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43D CONGRESS, } HOUSE OF REPRESENTATIVES. { EX. DOC.
1st *Session.* } { No. 193.

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# RECONNAISSANCE IN THE UTE COUNTRY.

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# LETTER

FROM

# THE SECRETARY OF WAR,

TRANSMITTING

*A report and map of a reconnaissance in the Ute country, made in* 1873 *by Lieutenant E. H. Ruffner, of the Corps of Engineers.*

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MARCH 19, 1874.—Referred to the Committee on Military Affairs and ordered to be printed.

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WAR DEPARTMENT, *March* 17, 1874.

The Secretary of War has the honor to transmit to the House of Representatives, in compliance with House resolution of the 6th instant, a copy of a report and map of a reconnaissance in the Ute country, made in 1873 by Lieutenant E. H. Ruffner, of the Corps of Engineers.

WM. W. BELKNAP,
*Secretary of War.*

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OFFICE OF THE CHIEF OF ENGINEERS,
*Washington, D. C., March* 16, 1874.

SIR: In compliance with the reference to this office of a resolution of the House of Representatives of March 6, 1874, I have the honor to transmit herewith a copy of a report and of accompanying map of the reconnaissance in the Ute country, made during the season of 1873 by Lieut. E. H. Ruffner, Corps of Engineers, chief engineer of the Department of the Missouri, under the orders of Brig. Gen. John Pope, commanding that department.

The map has been drawn upon stone, and, should Congress order its publication, transfers can readily be prepared and furnished the Congressional Printer.

By command of Brigadier-General Humphreys, and in his absence.

Very respectfully, your obedient servant,

J. G. FOSTER,
*Lieutenant-Colonel Engineers and Brevet Major-General, U. S. A.*

HON. WM. W. BELKNAP,
*Secretary of War.*

HEADQUARTERS DEPARTMENT OF THE MISSOURI,
OFFICE OF THE CHIEF ENGINEER,
*Fort Leavenworth, Kans., February* 21, 1874.

SIR: I have the honor to submit herewith my report on the reconnaissance in the Ute country, made during the season of 1873.

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I am, sir, very respectfully, your obedient servant,

E. H. RUFFNER,
*First Lieutenant Engineers.*

The ASSISTANT ADJUTANT-GENERAL,
*Department of the Missouri.*

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[Indorsement.]

HEADQUARTERS DEPARTMENT OF THE MISSOURI,
*Fort Leavenworth, Kans., February* 26, 1874.

Official copy, respectfully forwarded to the Chief of Engineers, Washington, D. C.

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JNO. POPE,
*Brevet Major-General, U. S. A., Commanding.*

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## REPORT OF LIEUTENANT E. H. RUFFNER, CORPS OF ENGINEERS, ON THE RECONNAISSANCE IN THE UTE COUNTRY, SEASON OF 1873.

The origin of the reconnaissance was the disturbed relations between the Ute Indians and the miners of the so-called San Juan district. This district was reported as embracing the claims located on the Animas River, and on the Lake Fork of the Grand River. These districts, formerly opened and abandoned, had become again the centers of wild speculation, and prospectors were reported as rushing there from all quarters. To the Ute Indians, occupying a consolidated reservation indefinitely large and embracing certainly one portion of the field and possibly all, the prospect of a wild flood of white men occupying their lands without any regard to their guaranteed rights was anything but pleasant, and they early protested against the invasion. An attempt was made, in the summer of 1872, to secure a cession from them of the disputed territory. It was a failure, however, and when the rush of miners in the spring of 1873 promised to be greater than usual, the remonstrances of the Utes grew to threats during the winter, and they firmly said that the miners must leave or war would follow. The consequences of a war with the powerful and intelligent tribe occupying the entire mountain region of Colorado could not fail to be dire. Of undoubted courage, possessed of all modern improvements in fire-arms, and with the secure fastnesses of the mountains to fall back on, the tribe could well put on a bold front in making their demands—demands undoubtedly just, as being the only fulfillment of a solemn treaty. The Indian Bureau, with justice, requested that the miners be kept out of the limits of the reservation, and the request was granted. Orders were issued to the military authorities to send such force as would be necessary, and to clear the district by a certain time. To do this it became requisite to know where the reservation extended. The eastern boundary was the 107° meridian from Greenwich, probably as difficult a line to establish as could have been chosen; orders were then verbally given to me to prepare a party to determine points on this line, to accompany the expedition while engaged in its unpleasant duty, and to furnish a full descriptive report of the district in question. The organization of the party, the details of field-work, the particular methods used, were entirely my own, and were faithfully carried out during the season. Written orders in detail were furnished to each member of the party, and where any failure has occurred in carrying them out I have noted it. The danger and, at least, difficulty of running an instrumental line in case of trouble with any Indians or miners was fully appreciated. Fortunately, however, not only on this account but on every other, just before the orders were carried out a new commission was organized to endeavor to secure from the Indians a cession of the disputed territory, and further proceedings were stayed to await the result. It may be stated here that these efforts were successful, and that later in the season a treaty was made with the Indians by which they relinquished the area desired, being pretty nearly that examined by the party on the first trip. The survey was not stopped by this change of action, the party being furnished with an escort and a schedule of proposed route which was fully carried out. Upon the return to Fort Garland it was thought advisable to keep the party in the field long enough to examine the various approaches to the Ute country from the Arkansas, and orders were given to that effect. This was fully and satisfactorily accomplished, and there will be found detailed accounts in this report of all practicable routes of reaching the Ute country from the East. It will be advisable to touch upon the various points of the report more in detail.

### REPORT OF THE FIRST ASSISTANT.

Mr. Henry G. Prout, civil engineer, was placed in charge of the survey. My previous acquaintance with him convinced me that he would faithfully carry out his instructions, and his high idea of duty gave the confidence which that alone can give. I can only add that my choice has been one that I could not have regretted. Soon after returning, and while working up his report, he accepted a position as major of engineers in the army of the Khedive of Egypt. Though regretting to leave his work unfinished he felt that it would not be wise to refuse the offer, and I accepted his resignation. The report, as here furnished, is partly his own, and has been completed by assistant, formerly recorder, Donald W. Campbell and myself. Being almost entirely from notes taken by Mr. Prout, he has received the credit for the report itself.

### REPORT OF THE GEOLOGIST.

The position on the survey to be given to geology was a subject of some thought, and I finally decided to attempt nothing more than a sketch showing the facts, and drawing as little on the imagination as possible; to keep confined to the practical, particularly in the mining districts, and to include such considerations as soil and timber. That Professor Hawn has been as faithful to his trust as could be desired is undoubted, and that little has escaped his eye is a natural consequence of his untiring industry. I speak decidedly in giving my testimony to the efficiency of the geologist's assistant, L. Hawn. His report on the Lower Animas River is one of the most interesting portions of the entire report. I beg to state that, although I have slightly altered the form of the geological report, I have endeavored to change nothing in its sense. I am in nowise responsible for any position held therein.

## REPORT ON METEOROLOGY.

It was not at first intended to do more than to carry along a barometer for an approximate profile, but the unwearied attention to the matter of Professor Hawn and Mr. L. Hawn has given this department a confidence it could not otherwise have possessed, and I consider the record as all that could have been expected. The tables, as furnished, will be examined again in connection with the numerous observations made for horary curves, and it is hoped a full and accurate set of tables will be the result of careful handling of very imperfect instruments. The various altitudes and thermometrical means are incorporated in the general table giving a synopsis of statistics, and in the special tables furnishing data for profiles of passes.

## ASTRONOMY.

This was perhaps the most important branch of the expedition. Mr. Prout was employed during the preceding winter largely in preparation and practice for this. The system of goedetic determination carried on by the instrumental azimuth and distance was checked in three ways by astronomy. 1st. The azimuth, of course, required daily determination by instrument, either sextant or theodolite. 2d. The astronomical latitude. 3d. The astronomical longitude by chronometers. The party was fitted out with two pocket-chronometers, by Hutton, only fair, and a box-chronometer. The latter, carried in a basket, was undoubtedly dropped by a soldier while carrying it, as the broken crystals determine, and the accident occurred before any use was made of it. Opportunity has not been afforded yet for a careful study of the full and numerous astronomical determination made. A careful series of lunar distances at the extreme west of the line will furnish some check on the entire distance from Pueblo. I, myself, assisted by Prof. T. H. Safford, of Dearborn Observatory, determined the longitude of Pueblo by telegraph. A full report of this was published in the Report of the Chief of Engineers for 1873.

I cannot help thinking that when carefully computed the determination of the 107° meridian on this line will have a close degree of accuracy.

The astronomical latitudes are given in the general tables, and it is intended to prepare a complete set of tables showing the various observations and computations.

## PHOTOGRAPHY.

The photography of the expedition was conducted by Mr. T. Hine, from Messrs. Copelin & Son, photographers, of Chicago. The indefatigable industry and zeal of this gentleman collected an unbroken series of views illustrating the entire trip, and marred only by two accidents, namely, on approaching Hamilton Pass he met with an injury from falling from his mule, which disabled him for several days and interferred with his collecting views of this interesting portion of the march.

Again, on the return to Fort Garland, through the carelessness of the officer furnishing transportation from Camp Loma, a wagon given to the party was so overloaded that thirty-eight negatives, embracing valuable views taken everywhere, were broken; an irreparable loss. I would particularly call attention to the following views in the subjoined list, as giving the clearest idea of the character of the country: Views on the Musca Pass line, 17–25; Barker's Park and Animas Mining Region, 47–59.

Engineer Mountain, 61.
Lake Creek views, 74–87.
Philosopher's Mountains, 100–104.
Lone Mountain views, 107–111.
Red Mountain Pass views, 120–125.

The successful negatives numbered 142 in all, and are mostly fine specimens of artistic work.

*Dry-plate experiment.*—I endeavored to experiment on this expedition with the dry-plate process. The materials and plates were furnished by the Scovill Manufacturing Company, of New York. Owing to shortness of time in preparation, no experiments were made before the expedition started. But as Mr. Hine had attempted the process and was reputed to take much interest in the matter, I relied upon his judgment and zeal in giving the matter a full, fair trial. One hundred and forty-four negatives were taken out, and sixty exposed were safely returned. I regret to state, however, that not one was successfully developed. I feel compelled to lay a large part of the failure to carelessness on the part of Mr. Hine. This gentleman, although continually urged to do so, failed to keep a record showing his times of exposure, kind of light, and such items as would naturally assist in forming the judgment as to results. Moreover, he made no attempts at experimental developing in the field. That this was an easy matter is shown by the fact that I myself have succeeded in developing views taken on the same lot of plates as late as in January, with the thermometer at 12°, and I a mere tyro in photography. Moreover, I succeeded in seven out of twelve attempted, and the last one or two were all that could have been desired. If he had tried in the field to develop one or two he would have seen the trouble and corrected it accordingly. As it is, however, the experiment must be considered a total failure, and from no fault of the plates.

[Here follows a list of one hundred and forty stereoscopic views, which is omitted.]

## MAPPING AND OFFICE-WORK.

In preparing the preliminary map the engraver, Ado. Hannius, has kept pace with the computors, and the lithograph has taken less time than a drawing would have done, as the facility of reducing directly on the stone. A final reduction will undoubtedly change the line somewhat, but so slightly as to be of no practical importance, especially in the present condition of the country. In computation, the astronomy has been in the hands of Assistant D. W. Campbell. Recorder Samuel Ansley has been in charge of the platting of the instrumental line and computing the stadia line, and Sergt. G. A. Sichtenberg, Company D, Battalion of Engineers, has assisted in a very intelligent and reliable manner. Sergt. R. N. Harper, of the same company, has performed nearly all of the clerical labor.

## EXPENSES AND GENERAL RESULTS.

The total number of miles run by the stadia was 908.64; the number of stations occupied where instrumental readings were made was 4,297, besides the astronomical determinations of azimuth. In addition to this must be added the miles traversed by the party in returning over lines previously run, and the various side-reconnaissances made where the prismatic compass was used. This is exclusive of the distance from Cañon City to Pueblo and of Fort Garland to Pueblo on the return. The total of this mileage is 550.85, making a grand total for the season of 1,459.49 miles.

The total cost of the expedition, as paid by this Office, was as follows:

| | |
|---|---|
| Expenses in the field | $8,127 20 |
| Deduct value on instruments bought and still on hand | 815 00 |
| | 7,312 20 |

To this must be added the salary of one draughtsman for six months, being the only addition made to my Office-force on account of the work.

| | |
|---|---|
| Field-expenses | $7,312 20 |
| Salary, one draughtsman six months | 720 00 |
| Add cost of printing map and incidentals | 8,032 20 |
| | 67 80 |
| | 8,100 00 |

Of this sum there was expended out of the allotment to this Office for the fiscal year ending June 30, 1873, $4,500, and out of the allotment for the year ending June 30, 1874, $3,600. Both of these allotments are from the appropriation for surveys for military defenses.

The various reports submitted herewith are approved.

Very respectfully,

E. H. RUFFNER,
*First Lieutenant Engineers.*

## REPORT OF THE FIRST ASSISTANT.

I have the honor to submit, in compliance with your instructions, the following report of the operations of the reconnaissance in the Ute country while under my charge.

The report proper will consist, first, of a general account of the organization of the field-party; secondly, of a general account of the instrumental work done, and the method of doing it; and, thirdly, of the physical description of the country passed over.

Appendix A is a brief discussion of the method and instruments used for keeping the topographical line, the results obtained, and the adaptability of these instruments and methods to such work.

In Appendix B you may find the reports of the geologist.

Appendix C contains a tabular statement of the distances from camp to camp, the latitudes and departures obtained, by stadier and theodolite and astronomical positions of camp and other data.

Appendix D contains copy of astronomical field-notes, with results of computations and comparison of chronometers.

Appendix E contains meteorological record-tables of altitudes, and data for profiles of several passes.

The plan of the organization of the field-party was as follows: A first civil assistant engineer in charge of the whole field-work, and who should personally do the instrumental work of the main stadia line and the astronomical work; a second civil assistant to do such work as might seem desirable; two recorders of instrumental work; one geologist, who should also, with his recorder, keep the meteorological and hypsometrical records; a geologist's recorder; a photographer, and such rodman, packers, and laborers as might be necessary. It was expected that enlisted men would do much of the work not requiring technical skill.

On the night of April 30, in obedience to your letter, I left Fort Leavenworth for Pueblo, accompanied by Recorders Samuel Anstey and Donald W. Campbell. I was followed 24 hours later by Geologist F. Hawn and Geologist Recorder L. Hawn. The whole party arrived in Pueblo in the evening of May 5, having been delayed 72 hours by a snow-blockade on the Kansas Pacific Railroad. At Pueblo I was joined by Second Civil Engineer James Bassel. We were occupied until May 7 in various preparations for the field. On the morning of May 7 we left Pueblo, beginning the line from Pueblo to Fort Garland. The longitude of Pueblo was being determined by telegraph, working in connection with Denver, and in order to determine the longitude of Fort Garland with the greatest accuracy possible to our methods, and also to obtain some test of the closeness of our work, I was instructed to run, between Pueblo and Fort Garland, two entirely independent lines over the same ground. The working party was accordingly organized as follows: First Assistant Prout and Recorder Campbell ran one instrumental line; Second Assistant Bassel and Recorder Anstey the other, and the stadia rods were carried by enlisted men from Fort Garland; these parties were on foot. The geologist and his assistant were provided with a spring-wagon. The instruments and methods used in this portion of the survey were essentially the same as those used throughout the summer, described in Appendix A. The lines were begun at the longitude post at Pueblo, and the first meridian was taken from that of the astronomical transit used in your longitude work. The true meridian was obtained at the second and fourth camps, respectively, 18.14 miles and 46.83 miles from Pueblo, and at Fort Garland by observing with a sextant the altitude of a star at the instant when the theodolite was set upon it. At first two stars were observed, one east and one west, but owing to the practical difficulties of observing with instruments of small field, defective illumination, and no finding circles, we soon came to rely altogether for meridians upon observations of Polaris, his deviation being computed from known altitude or time.

Two instrumental lines were run through from Pueblo to Fort Garland, entirely independent and without break, except that Mr. Bassel lost his azimuth on the first day out, and was obliged to correct his assumed azimuths from Mr. Prout's line at the first camp.

We reached Fort Garland on the afternoon of May 13. The line run in these seven days was 85 miles, an average of 12.14 miles a day, of careful instrumental line. The longest distance run in one day was up the Sangre de Cristo, from Badito to the summit, 13½ miles. With almost no exception the country was open, and usually the only limit to the length of sights was the capacity of the instrument. Nevertheless, it was found to make these days' work on foot involved steady, smart work, and no little fatigue. Afterward we found that in open country, mounted, eighteen miles was not particularly hard work. Sextant observations were obtained at camps 2 and 4 for latitude by Polaris off the meridian, and for time by stars east and west of the meridian. Clouds prevented observations at other camps, except at No. 5, near the summit, where timber and mountains made observations difficult, and the very fatigue made a small obstacle great.

The latitude of Fort Garland was determined by eighteen observations of Polaris off the meridian May 14 and 15, and thirteen similar observations on July 31.

The mean of these observations was 37° 23′ 17″.33, and the range from the least single result to the greatest was 0° 01′ 25″.3, giving probable error of single result 14″.64, and of mean of twenty-five results = 02″.93.

### *General description of country.*

Pueblo is situated on the Arkansas, a stream at this point 100 feet wide and 2 feet deep, with a strong current. On either hand is a high, broken mesa country, stretching away south and west to the foot-hills of the Sangre de Cristo range, and on the north to those of the great divide of the waters of the Platte and Arkansas, of which Pike's Peak is the easternmost peak of considerable height.

Due west from Pueblo the summit of the Greenhorn Speer is from 35 to 40 miles distant. Here it is a rugged range about 3,000 feet above the Arkansas Valley, and at this season showing much snow. It was impossible to estimate here the N. E. limit of the foot-hills. From this point to its end at Badito the range has a general trend S.S. E. and our S. W. course conveyed rapidly with the mountains, (country becomes more and more broken,) and the terrain changes accordingly from flat prairie sloping gently toward the Arkansas, to mesas cut by deep waterways, (the Mexican "arroyas,") and presenting bluffs of considerable height, and finally to rolling foot-hills. From Pueblo to the vicinity of the Saint Charles, about 10.7 miles, is a flat prairie without trees or water, with their gravelly soil supporting little vegetation, and that little being mostly small cach and sage-brush. The Saint Charles, at crossing, is about 40 feet wide, and 2 feet deep, a clear, rapid stream; the bluffs on either side are 500 to 1,500 feet apart, and 75 to 120 feet high, and between there is a fertile bottom, bearing a belt of cottonwoods, and containing a few ranches. In the vicinity of the stream on either side the surface is broken into low bluffs and hills, and continues so to Badito.

From the Saint Charles to the crossing of the Muddy, about 7.5 miles, our route skirted the eastern limit of the foot-hills of the Greenhorn, and beyond that point it may be considered as having fairly entered those foot-hills, although, in all of the distance from Saint Charles to Badito, are frequent wide spaces of flat mesa, the hills often have a thin growth of small cedars, but no timber of any value, and the soil is everywhere of little account, except in the narrow river bottom. The streams crossed between Pueblo and Badito are the Saint Charles at 10.7 miles, the Muddy at 18 miles, the Little Greenhorn at 27 miles. A stream at 29 miles, the Apache at 34 miles, and the Huerfano at Badito 46.8 miles from Pueblo. On all these streams are a few ranches in the narrow strip of bottom-land. These bottoms seem fertile. The uplands furnish a sparse growth of grass, but without extensive and systematical irrigation this region will sustain but a small population.

Badito is merely a forage station, with a store for the few Mexicans living hereabouts on the Huerfano. From Badito the ascent of the Sangre de Cristo Pass commences; this is a steady climb of 13½ miles, the last third being very steep. Our barometer not having arrived at this time, no profile was obtained of this pass, but Gunnison's profile sufficiently demonstrates its uselessness as a railroad pass. For a wagon-road between Pueblo and Garland it is the most direct pass that can be obtained, and for that reason will probably not be abandoned for the lower route by the Huerfano River, and Musca Pass northward, or the Vita Pass on the south. The best grade to be obtained, in the eastern ascent of this pass, is not less than 6 in 100 for certain distances of one-third of a mile, and it must be blocked by snow for a long season; otherwise it presents no obstacles to a good wagon-road; in fact, such a road already exists.

The ascent on the left is the same, only the mountains are of short flanking spurs, and the deep courses of small streams. On the right is the Huerfano River, cutting through the last hills of Greenhorn, and the Huerfano Park, a high, rolling valley, lying between the Greenhorn range and the Sangre de Cristo. Both of these ranges present high, well-marked crests, rising high above the out-lying hills, not at all the vague jumble seen on the maps.

The Sangre de Cristo spur puts off from the main range west of the Puncho Pass, near the head of the Arkansas, about latitude 38° 30′, and longitude 106°, runs down north and east of the San Luis Valley to the point where we crossed it, and continues southward until it is known as the Raton Mountains. I have become familiar with the aspect of this spur from its separation from the main range to the Sangre de Cristo Pass. In all that distance it is a sharp range, rising abruptly from the San Luis Valley, more gradually from the hills, skirting the Arkansas Valley, high above timber line, of singular variety and boldness. The passes which we examined will be mentioned at the proper time. The west descent from the Sangre de Cristo Pass is down the Sangre de Cristo Creek, a small, bright stream. On this (the west) side the grade is more uniformly distributed.

The road is fair; the valley of the Sangre de Cristo is one or two hundred feet wide and fairly grassed with little timber. The hills on either hand rise from 200 to 1,000 feet above the stream, and present soft rolling outlines. About four miles from Fort Garland the Ute Creek is seen to debouch from between Graybuck Mountain and Sierra Blanca, and the road, leaving the Sangre de Cristo, crosses a barren plateau to that stream which it follows to the fort.

*Fort Garland.*—We arrived at Fort Garland on the evening of May 13th, and were occupied until the 20th in a preliminary reduction of notes to that point, and in completing the outfit for the field. Little need be said of Fort Garland; it stands on the margin of the desolate San Luis Park, at the base of the Sangre de Cristo Mountains, a cluster of adobe buildings, comfortable and well arranged, but somewhat out of repair. The post is abundantly supplied with fine water by an acequia from the Ute Creek, and with piñon wood from the hills. Abundant grazing is found in the hills near by, and numerous ranches on the Creek; the Sangre de Cristo and the Tunchera supply it with beef, vegetables, grain, and hay. At the camp, at the summit, we were joined by the photographer, Mr. Hine.

At Fort Garland I received the barometers, two small aneroids by Cassella, and one mercurial cistern barometer. All of these instruments were defective. The aneroids were too small. The cistern barometer was defective, in that its vernier read to hundredths of an inch, and the graduated scale had a range of only about 10½ inches, the minimum reading being 20.30 inches.

We finally left Fort Garland on the morning of the 20th May. The organization and work of the party were the same as on the route from Pueblo to Fort Garland, except that the stadia rods were carried by four civilians hired for that purpose, the post commander and commander of the company from which our escort was taken having declined to order soldiers to do this work. From this point the party was mounted on mules, and was accompanied by an escort of a sergeant and four men of Company F, Eighth Cavalry.

*San Luis Park.*—From Fort Garland we proceeded across the San Luis Park, north of west, about twenty-six miles to the Rio Grande, striking this stream at the point where it makes its great bend to the southward; thence our route was up the Rio Grande. From the point of striking the Rio Grande to the summer camp of a detachment of the Eighth Cavalry, "Camp Loma," two lines were run, as in coming from Pueblo, but afterward only one line was carried.

My instructions directed that a main stadia line should be run by the first assistant, and a series of side lines by the second assistant, and I attempted to carry out this plan. The first day out from Camp Loma, Mr. Bassel ran a line of about eight miles up the South Fork of the Rio Grande, and the second day he went ahead with his party, but failed to find a point at which to leave the valley of the Rio Grande. It was found that on both sides the rugged timbered slopes of the main range were well-nigh impassable in any direction, and particularly across the courses of the small tributaries; that side lines to be of any value must lead to the summit at least, and would necessitate the separation of the detachment, running them from the main party for indefinite periods—certainly, longer than one or two days; and that, moreover, our necessary ignorance of the country made it impossible to designate, with any accuracy, the points of rendevous. Another very important consideration was the grave wear upon the animals during this work. On the whole, I considered the delays likely to arise in attempting a system of auxiliary lines would not be compensated by the information gained, and it seemed wiser that one line should be run by the second assistant, aided, when necessary, by another party, and that the time of the first assistant be devoted to the general conduct of affairs, to securing careful descriptive notes of the country, and obtaining frequent topographical sketches from commanding positions.

To Recorder Campbell was given the duty of preliminary computation necessary to determine our position as we proceeded. With little exception this was the plan of our work throughout the season.

At Camp Loma wagon transportation was entirely abandoned, and from this point our transportation consisted of a train of thirteen pack-mules, packed and handled by the soldiers of the escort. Here we were joined by our escort, consisting of thirteen enlisted men of Company B, Eighth Cavalry, and, for a time, we moved in company with Major A. J. Alexander, and Company B, Eighth Cavalry. This company left us, however, at Camp 23, the last camp east of the main divide.

The instrumental work westward from Fort Garland varied in no way from what has already been described, and the computations were carried on as accurately and rapidly as possible in order to locate the 107th meridian of longitude, when we should cross it, which was done. Sextant observations were made, when practicable, for latitude, and time and azimuth were observed as before described. On arriving in Baker's

Park, the seat of the San Juan mines, now much talked of, a division of the party was made.

Recorder Campbell and Geologist F. Hawn, with two rodmen, were left in the park to make a topographical and geological survey of the mining district, while the rest of the party proceeded down the Animas River to a junction with the supposed trail of Colonel Macomb, surveying engineer, made in 1859.

*Description of the country from Fort Garland to the bottom of Animas Park.*—As I have said, Fort Garland is on the eastern margin of the San Luis Park. Park is a very euphemistic name for a dreary desert.

*San Luis Park.*—This park is an immense, nearly level, sandy plain of irregular outline, with its long axis trending from the northern end a little east of south. Its greatest length is about sixty miles, and greatest width about fifty. It is bounded on the north and east by the Sangre de Cristo Range, west by the eastern foot-hills of the main range, and southward it gradually changes into the high mesa country of the Rio Grande Valley. From all these mountains numerous small streams flow out into the desert, and quickly sink in the sand. Above the line from Fort Garland to La Loma, in the interior of the park, is a string of small ponds and marshes, which have been approximately located by our lines, and which may be the re-appearance of streams which have sunk above, and in the same way I should account for the appearance of a small, cool, pure spring, rising in the midst of the desert about eighteen miles west of Fort Garland. This spring discharges a considerable volume of water, which flows down the sides of a small grassy mound, and is absorbed again into the sand.

Along the eastern side of the park immense sand-hills are frequently seen piled high against the mountains, and lesser ones rise from the plains, southerly, from the spring mentioned. From Fort Garland westward to the river is mostly through heavy sand, thickly covered with sage-brush and small cach, with a scant growth of bunch-grass. Small herds of cattle and sheep, mostly native bred and in poor condition, pick a living from the sparse grass, getting water from the borders of the marshes or at the streams near the hills.

*Rio Grande.*—After reaching the Rio Grande our route lay along the left bank of the river. Here is a narrow belt of land, reaching back for an average distance of perhaps one-half mile, from the very tortuous river, which is already watered by the numerous sloughs or bayous, or easily irrigated artificially. This land seems to be very fertile, and bears fine-looking crops of cereals and grass, and there are perhaps a dozen ranches from the bend of the river to La Loma, a considerable growth of cotton-wood along the river. Beyond this belt the desolation of the park stretches to the mountains. Along here the Rio Grande is, at this season, a stream of perhaps 200 feet wide, and 2 to 4 feet deep, swift and turbid. About sixty miles from Fort Garland the river debouches from the mountains into the plains of the park.

*Del Norte and La Loma.*—Here, on the north side of the stream, stands the town of La Loma, and on the south side, a short distance higher up, is Del Norte. Within a year or two these towns have assumed importance as points of departure for the "San Juan mines," and are going through a small fever of real-estate and trading speculation. When I last saw them La Loma contained about twenty houses, and Del Norte perhaps fifty, mostly of adobe or logs, but there is now much wild talk of their rapid growth and great prosperity.

These towns are at the mouth of that remarkable cul-de-sac of the mountains, at the bottom of which the Rio Grande has its source. The great Sierra Madre, the divide of the Atlantic and Pacific water for a long way holds a pretty uniform southwardly course to about latitude 38° and longitude 106° 30′. At this point it turns westward abruptly, and continues nearly due west to a point about latitude 37° 45′, and longitude 107° 28′, where it turns sharply southward, and then eastward, returning upon itself, and in latitude 37° 30′ and longitude 106° 45′ resumes its southerly course. In all this strange detour the range is definitely marked as a bold, ragged, unbroken chain, but only at its western limit, about the bottom of the loop, does it rise to its greatest heights. Here, high above timber-line, among snowy peaks, magnificent in their lines, sublime in their masses, are the fountains of the Rio Grande del Norte.

Our course up the river lay between the foot-hills, which, on either hand, slope from the summit of the main range nearly to the water. At the mouth of the cul-de-sac the foot-hills are about half a mile apart; they seem to be basaltic, present sharp crests and precipitous sides. They are from 200 to 500 feet high here, rise rapidly as they recede toward the main range, and are sparsely timbered and grassed. Only small piñons and junipers are found on the near foot-hills, and few of these, but farther back in the mountains there seems to be fair pine timber.

*Rio Grande at exit from the mountains.*—The foot-hills recede gradually, so that at four or five miles above Del Norte the valley is perhaps three miles wide; there they gradually close in again, until at fifteen miles above Del Norte the valley has become a varying space of from a few yards to half a mile, seldom more.

From Del Norte to Camp Loma, seventeen miles up the river, is a pretty valley. The bottom-land seems fertile and warm, and the upland generally affords good grass. Along the river is a fringe of cottonwoods, and here and there clusters of pretty well-grown yellow pines. On the foot-hills are small piñons in sufficient quantity for fuel. In this valley are several farms and stock-ranches. In all this region early and late frosts must prevent the growing of Indian corn, but the small grains can be cultivated with success, and it is an admirable grazing country. Cattle run and thrive, unsheltered and unfed, summer and winter.

*Camp Loma.*—Camp Loma was, when we passed up, at the end of wagon transportation. To this point the wagon-road was excellent, as, generally speaking, in all this dry country, the finest possible roads are made by traveling in one track for a little time over the gravelly surface. A road-bridge was nearly completed over the Rio Grande at Del Norte, and the ford at that place is excellent.

*Camp Loma to Antelope Park.*—Beyond Camp Loma, a road, as good as is to be desired, may be obtained as far as the western limits of Antelope Park, in about two or three miles from Del Norte, by bridging the river a few times. When we passed, the only crossings were by swift, rocky fords, but with a pack-train, once on the north side, recrossing was unnecessary. Since our return a company has been organized in Del Norte for the construction of a road over the route indicated, and a large part of the work was under contract when we last left Fort Garland.

Camp Loma is near the confluence of the Rio Grande and its south fork here; the foot-hills slope steep to the valley, which is from 500 to 2,500 feet wide. The foot-hills rise 300 to 1,000 feet above the river, and are generally heavily timbered with pine. In the gulches and along the valley is much very good pine timber and bunch-grass of excellent quality.

Our trail crossed the South Fork about three-quarters of a mile above Camp Loma, and the Rio Grande one mile farther. The South Fork is a stream about seventy-five feet wide, three to four feet maximum depth, and a current of four or five miles an hour. The ford is no way difficult. The main river, at the ford, is about one hundred and twenty-five feet wide, four feet greatest depth, current of four or five miles an hour, and rocky bottom, but with care the ford offers no difficulties to animals or wagons. Above this ford the trail continues along the north side of the river, and as the stream winds from side to side of the narrow valley, impinging, now against the northern foot-hills, and then against those of the south, one, to avoid crossing, must often keep on the slope high above the river. As this slope is steep and usually of rock *débris*, the trail across these points is often difficult, and sometimes dangerous for animals too heavily laden or carelessly handled. At different points several of our animals rolled from the trail into the river below, and were only saved with some difficulty and the loss of valuable property. But it seemed still more dangerous to attempt to ford the river. In this vicinity, from twenty to thirty miles from Del Norte, the valley is quite insignificant, never more than 2,000 feet wide, and seldom so much. On the north side the foot-hills rise from the river to heights of from 300 to 1,000 feet, and, beyond these, from one-half mile to a mile away, rise the mountains in sheer cliffs, columnar in appearance, rising from 50 to 500 feet to a broad terrace; from this terrace rise other cliffs to greater heights, crowned by a second terrace with cliffs above. These cliffs are apparently of reddish granite. The terraces bear some small pine. South of the valley the mountains have earth-slopes and undulating sky-lines. They are densely timbered to the summit with pine.

*Wagon-Wheel Gap*—About thirty miles from Del Norte the river passes through Wagon-Wheel Gap, a short narrow cañon, with just room for the river and a dangerous trail. This gap is rather a picturesque place. On the north side is a sheer cliff, perhaps four hundred feet high, of partially metamorphic sandstone serrated with green shale. On the south side the hills rise very steep for, perhaps, one thousand feet.

Above this gap the hills break away rapidly, giving a valley of an average width of about three-fourths of a mile. Just here the mountains have mostly lost the crags and cliffs seen below, and appear as gently-rounded timbered hills, with an occasional sharp peak. As its course hitherto, the river crosses and recrosses the narrow valley, washing first the northern and then the southern foot-hills. About one mile above Wagon-Wheel Gap a spur from the northern hills runs out into the valley and ends abruptly at the river in a peculiar cliff about one hundred and fifty feet high, of fused limestone and shale, the strata curving upward sharply toward the west, giving the cliff, as seen from the south, the appearance of the beak of an immense iron-clad. From this vicinity on up the river the foot-hills gradually become less marked, and the mountains rise more abruptly from the valley. On either side they are seen to be from two thousand to three thousand feet above the river; on the south they usually present slopes rounded and gradual rather than otherwise, are heavily timbered to the visible summit, and without snow. On the north side the mountains are nearly timberless, precipitous, cut by yawning chasms, and often snow-crowned at this season.

From Camp 18, about forty-two miles from Del Norte, in the hills north of the Rio Grande, Mr. Hine and I ascended the great mountain bluff on the foot-hills of which Camp 18 was situated, at a distance of about three-quarters of a mile W. N. W. from the river and three hundred feet above it.

*Bristol Head.*—This mountain, to which the name of "Bristol Head" was given, has a triangular base, one axis of which lies in a nearly due north and south line. The southeast face of the mountain is of the same general appearance just ascribed to the mountains north of the river, and the southwest face is a nearly perpendicular precipice, in one place exceeding two thousand feet in perpendicular height. The summit was distant about six miles from camp, (measured on our trail,) and the ascent somewhat difficult, but the magnificent prospect well repaid us for our exertions. From the northeast, around to the southwest, stretched the Uncompahgre Range, a series of great peaks; the whole range at this season covered with unbroken snow down at least fifteen hundred feet from their summits.

The Sierra La Plata was visible, extending along the south side of the Rio Grande from its "Box" Cañon to Wagon-Wheel Gap, the nearer peaks, about 3,000 feet above the valleys, timbered to their summits and with earth-slopes and rounded lines. Farther south the "back-bone" of the range, a mass of snow-peaks; below, the Rio Grande could be seen for over 40 miles of its course. On the face by which we ascended was a bank of snow, climbed by cutting steps in its face, and the summit was covered with snow, through which we broke mid-thigh deep, encountering a pelting snow-storm as we descended. Spruce-pines and aspens were found to within 1,500 feet of the summit, the pines tall and straight above, a few stunted piñon in sheltered places. From Camp 18 to Camp 19 the trail lies around the base of "Bristol Head" to its southern apex.

*Camp* 18 *to* 19.—About two miles south of Camp 18 the foot-hills recede from the river, leaving a grassy bottom on the west bank, having an average width of about 1,000 feet, and extending for a distance of about two miles in a south-southwest direction, in which we found a cattle-ranch. At the southwest end of this bottom, and on the south side of the river, a stream comes in from the southeast, through a narrow, steep-sided valley, to which the name of Rainy Cañon was given, because, on all occasions, when seen, rain was falling up the cañon. Nearly opposite the mouth of Rainy Cañon is the dry cañon, through the trail to the lake fork of the Gunnison passes in a northwest direction close to the western foot of Bristol Head. At this point commences a series of smooth, rolling grassy ranges, lying between the cañon at the southwest face of Bristol Head and the Rio Grande. These ranges become gradually less steep until, after passing the divide between Clear Creek and Crooked Creek, they break down into the smooth bottom known as Antelope Park, a beautiful piece of fertile land about two and a half miles in length from the junction of Clear Creek and the Rio Grande northwestwardly, and about a mile and a half wide.

The valley of Clear Creek is about twelve miles in length, having gently sloping sides, thickly covered with bunch grass. It has an average width of about a mile and a half of land sufficiently level for cultivation. A well-worn Indian trail is found nearly the whole length of the valley.

*Camp* 19 *to* 20.—From Antelope Park up the Rio Grande the trail is on the north side of the river, at a height of from fifty to two hundred feet above it, on a very steep grassed slope. Near the river this slope ends in a cliff. Above the trail on the north is another cliff, of one to two hundred feet high. The mountains to the south are about 1,800 feet above river, timbered to the summit, having rather steep but even slopes to the river. Plenty of good bunch-grass and fuel on the trail, but no water accessible.

At Camp 20 the hills open out, leaving a narrow bottom cliff on the left, rising about 200 feet above the trail, the slope from the foot of this cliff to the river being very steep, and grassed in the neighborhood of Camp 20, but, from a point about 600 yards above, covered with a dense growth of small timber for a distance of about four miles. A mile below Camp 21, the gorge of the river widens into a valley about half a mile wide, with a flat, sandy bottom, in which the river winds in a very crooked course and with a comparatively sluggish stream. About three miles above Camp 20 the trail passes along the face of a very steep and dangerous bluff of slide rock at a height of about 200 feet above the river. Here several of our mules stumbled and rolled into the river, causing the loss of a theodolite box and contents, some cooking utensils, and small articles. Above this bluff, for a distance of about five miles, the river runs in a flat, sandy bottom of from 200 to 1,000 feet in width, thickly fringed with willows.

*Camp* 20 *to* 21.—About five miles above Camp 20 the river is crossed by an Indian trail, the main trail of the Utes from the Los Pinos agency to the country south of the Sierra La Plata.

"*Lost trail.*"—On our return this trail was followed to the valley of Crooked Creek, down which we traveled to Antelope Park on a much better trail than that found along the Rio Grande; in fact, perfectly practicable for wagons, except for a short distance up the steep ascent to and through boggy ground on the summit between the head of Crooked Creek and the Rio Grande. The appearance of the valley and stream from the bluff above Camp 20 indicates that the whole valley was filled with water at a comparatively recent period, and the miners of the San Juan region informed us that Spanish records extant in Santa Fé describe a lake here as late as 1777.

*Camp* 21 *to* 22.—Camp 21 was at the upper end of this bottom, where the trail is lost in the willows and swamp, and on the edge of a small stream flowing from the northeast. On the north are cliffs about 1,000 feet high, having a crown of trap. At a point about due north of Camp 21 these cliffs trend to the southwest, and have a very unusual and remarkable appearance both in color and form. The color is a light, rather bright, greenish-blue, the color of verdigris, and of a friable, sandy substance. The cliff is about 400 to 500 feet high, distant about a mile from the river at Camp 21, and from the cliff-foot to the river is a beautifully-grassed and open-timbered slope, cut by deep ravines where the streams come down. As the cliff disintegrates by the action of the weather, isolated pinnacles are left standing boldly out, of nearly the full height of the cliff. Their singular color, contrasted with the bright green of the young aspen-leaves and the dark green of the pines, formed a beautiful picture. From Camp 21, for about four miles, the trail is good, over open ground, with good grazing and fuel for camping.

There is no bottom-land, but the valley is about half a mile wide on the left bank and all easily-sloping foot-hills. On the right bank the mountains slope to the river of the same general character as below, getting, however, more rugged as we ascend, and timbered to the visible summits. About two miles from Camp 21 the trail struck the wagon-trail made by the Little Giant Mining Company when transporting machinery the year before, and this was followed to Camp 23. The amount of wreckage strewed along the whole length of the wagon-trail followed by us from this point was sufficient evidence of the difficulties encountered by the pioneer teamsters of this region. At the crossing of Wagon Creek, a blacksmith's forge and wagon-shop had been erected, and a bridge built over the creek. About a mile from this crossing the road enters a dense pine-forest, and the ascent is so steep that the wagons must have been hauled up by tackles hitched to the pine-trees. This ascent continues to a point about two miles from Camp 22.

*Camp* 21 *to* 22.—At this summit the timber ends, and the trail descends rapidly into the valley of the Rio Grande, striking the river between the mouth of Hine's Fork, south, and Pole Creek, north. Except a few small swamp-holes, the trail is here not difficult, but rather steep, with abundance of good grass, water, and wood. On the north the mountains rise about 2,000 feet, with earth-slopes and timber, above which are broken cliffs of about 1,000 feet, composed of a gray stratum crowned with a dark red granite. These cliffs are furrowed and worn into pinnacles and buttresses. On the right bank the mountains rise about 3,500 feet above the river, timbered to snow-line, above which are the bald peaks, snow in patches. Above Camp 22 the trail rose rapidly on the mountain-slope, the timber becoming small and scrubby and more sparse. We found many snow-patches June 7, 20 to 50 feet wide, and 2 or 3 feet deep. The mountains on both sides of the river are snow-capped summits, about one to two miles distant, and about 2,500 feet above the river.

*Camp* 22 *to* 23.—On the north are cliffs of blue and red limstone ande conglomerate, upheaved, and above these, on the crown of the mountsains, are cliffs of red and gray granite.

*Camp* 23, *just before the divide.*—Camp 23 was about 600 feet above the river, on a very steep slope, near a small snow-stream; poor grass; dry wood scarce. While camped here, on Sunday, June 8, we had a snow-storm, with thunder and lightning, which lasted several hours; but the snow melted nearly as fast as it fell. Mr. Lawrence Hawn, who had ascended Mount Canby, was caught by the storm, and received several strong electric shocks. During the snow-storm an avalanche rolled down the side of one of the mountains on the opposite side of the valley, sounding louder than thunder. About 9.30 p. m. the snow ceased falling; the clouds broke into thick, dark masses, lit by the nearly full moon; the mountains loomed grandly through these masses of cloud, with their tops gleaming in the moonlight. The dense black masses of pines among and below the shining snow, the clouds, bright above and somber beneath, made a grand scene of mountain gloom and mountain glory. Major Caraher and his troop left us at this camp, returning to Antelope Park, leaving with us an escort of three non-commissioned officers and fifteen men.

On Monday, June 9, we broke camp and started to cross the divide, at 7 a. m., Messrs. Bassel and Anstey running the stadia line. The summit was at a distance of about two and one-half miles from Camp 23; the trail being for about half a mile through patches of stunted pines in boggy morass, soon worked into almost impassable mud by the passage of the pack-train, and, for the rest of the distance, over and sometimes through an almost continuous sheet of snow, in many places of great but unknown depth, generally, however, from 4 to 8 feet. The summit, where crossed, is a "knife-edge," and the view from it limited, but very grand. Around, in every direction, sharp basaltic or trap peaks, with deep gorges and slopes of rock *débris*, and, for the most part, covered with snow to far below the level of the pass. Westward, through a narrow, steep gorge, between lofty crags, is seen the range west of Baker's Park, snow-crowned cliffs of basalt, porphyry, and trap. The highest timber seen is spruce-pine. On the summit are patches of low, dense willow, exposed in a few places where the snow has been blown away. It was a source of regret to the whole party that the illness of Mr. Hine, the photographer, prevented his taking views from this point. As the train wound around and over the rocks approaching the pass the scene was very picturesque, but when we got into the snow all thoughts of the picturesque fled before the necessities of the hour. At first the crust would generally bear up the animals, and when they broke through there was no great difficulty in extracting them. But as we rose the snow became deeper, the sun shone fiercely, and the crust thawed and became treacherous, and where an animal broke through a path had to be shoveled and trodden for it to get out, and another for any animals that were behind to get around the broken place. The summit was reached at about noon, and for the first mile beyond the work was very severe for men and animals, but no packs were lost, and no more serious accidents occurred than the casting of shoes from the animals. This first mile west from the summit was, all the way, through snow from one to five feet deep, and a trail had to be shoveled or trodden for nearly the whole distance. About three-quarters of a mile west of the summit we crossed Hamilton's Creek on the snow-crust. One mule floundered in the snow and fell with its head in the creek, and was only saved with great difficulty; another, blinded by the storm, exhausted, and totally unable to proceed, was abandoned with the hope that it would make a voluntary effort when rested, which it did, reaching our camp shortly after we left there the following morning. About a mile west of the summit we left the snow and entered pine-timber, descending very rapidly on a soft soil trail along the right side of the gulch of Hamilton Creek for about half a mile, where we made Camp 24 in large pine-timber at 8 p. m., after upward of twelve hours continued march, most of the time in the snow, the whole distance accomplished being about four miles. We were all thoroughly tired, and although the grass was only fair, and on steep slopes, it seemed unadvisable to go further in search of better. The timber was well-grown spruce-pine, too low-branched for lumber of any value; water abundant. The night was fine, but we were all too fatigued for astronomy. The pass and creek were named "Hamilton," after the man who took the first and only wagons over the mountains, bringing machinery for the Little Giant Mining Company, in the season of 1872, a labor of fifty-eight days from Del Norte to Baker's Park.

*From Camp 24 down to Baker's Park.*—From Camp 24 the trail was down Hamilton Creek to Stony Creek; down this to Cunningham Creek, thence down the last named to the Animas, in Baker's Park, where we made Camp 25. The trail in many places was steep and difficult, but not dangerous. The trail was mostly earth, dense willows, and cobblestones in the creek bottom; no grass of any account till Baker's Park is reached. The view going down was very grand; on the north Mount Galena rises to a height of 3,000 feet above the valley, a mass of basalt or trap seamed with quartz; on the south rise the mountains of the main range, also 3,000 feet high, and also basaltic, with seams of ferruginous quartz. These mountains are nearly vertical cliffs, with *débris* slopes at the foot. The valley of the Cunningham is never more than four hundred feet wide, and has small growth of anything but willows. Through the mouth of Cunningham Gulch is seen the snow-covered peak called King Solomon, of the Sierra La Plata, west of Baker's Park; eastward the view is limited by the snow-peaks near

Cunningham Pass, peaks of sharp, volcanic rock. Silver, galena, and some gold are found on Mount Galena, and nearly the whole face of the mountain has been "claimed" by miners. In Baker's Park we found fair grazing and abundant wood and water. Baker's Park is a somewhat crescent-shaped valley, concave westwardly, the long axis lying nearly N. E. and S. W., and nowhere exceeding one-third of a mile in width. On the west are the Sierra La Plata mountains, on the east, above Cunningham Creek, Galena Mountains and the Uncompahgres; south of the Cunningham are the peaks of the main range. Looking northwardly, the view is ended at a distance of about two miles by the westwardly trend of the valley; southwardly, it is ended by the snow-peaks south of Hamilton Park. The mountains surrounding the Park are mostly of basalt, trap, and kindred rocks more or less metamorphosed. In these rocks are numerous veins of quartz injected in all conceivable directions. These veins are very noticeable on the face of King Solomon Mountain, opposite the mouth of Cunningham. On this mountain a vein of quartz is seen sloping from crown to base, at an angle of about 60° with the horizon, and crossing this, in all directions, are smaller veins, the whole presenting an appearance so remarkable that the attention of the most negligent traveller down the Cunningham Valley is arrested by it. The day after our arrival at Baker's Park a line was run by Mr. Bassel up the valley of the Animas as far as Eureka Cañon, and subsequently continued up the Eureka Cañon by Mr. Campbell, and by prismatic compass up the valley of the Animas, across to the headwaters of the lake fork of the Grand River by myself. An account of the country there seen will be given further on.

The Little Giant Company informed me that ore had been assayed yielding from $100 to $27,000 per ton, averaging $500. They were engaged in erecting a Dodge's crusher and amalgamator, which were set to work the day we left the valley on our return. The mine is situated in a gulch, on the left bank of the Animas, between Baker and Hamilton Parks, and the drive, about 6 feet wide and 15 or 16 feet high, divided into two stages, had reached a depth of 60 feet in the side of the cliff. Some silver-ore had been taken out, and some fears were entertained that the lead might run into silver. The lead is a quartz-vein in trap or basalt, said to be 30 inches thick, and crossed by several smaller veins much like those described in the face of King Solomon.

The valley of the Animas, between Baker and Hamilton Parks, is entirely without bottom-land, the only spaces found being here and there a "berm" between the foot of the mountains and the bluff overhanging the creek. From Camp 25 a miner's trail is found on both sides of the river; that on the left bank leading to the Little Giant Company's mining camp, below which it crosses the river, joining that on the right bank. We took the trail on the right bank, as the ford above Cunningham's was reported the best. The trail between these parks was good and, for the country, easy; the divide between the two parks being a little above the Little Giant Gulch.

Our Camp 26 was on Cement Creek, near its junction with the Animas, in Hamilton Park, and I here divided the party, leaving Mr. Campbell, Professor Hawn, two rodmen, and a miner guide to make a thorough topographical and geological survey of the valley of the Upper Animas. The report of Professor Hawn will be found at the proper place in the geological report, and Mr. Campbell's report is here inserted.

*Mineral Creek.*—At this season Mineral Creek is a stream, the size of which varies greatly at different hours of the day. At minimum it is about fifty feet wide, two feet deep, and with a current of about eight or ten miles an hour. After the sun has caused the snow to melt (at about 2 or 3 p. m.) it is at its maximum, and is dangerous to ford at the most favorable fording-places, being up to the girths of a medium-sized mule, and perhaps seventy or eighty feet wide, with a very swift current. For about half a mile above its junction with the Animas its course is close to the foot-hills on the south side of Hamilton Park, above this its course is through a valley, nowhere more than a quarter of a mile wide, of steep, rounded foot-hills, having no flat bottom-land whatever for a distance of about three-quarters of a mile from Hamilton Park, but flowing between banks 50 to 100 feet high. Thence to the forks there is a narrow strip of very strong black soil bottom-land, in many places, deep-bog, and mostly covered with a dense growth of willows, through which it is very difficult to force a path. On the left bank the mountains as seen from the valley are precipitous, weather-worn cliffs of different formations, with slopes of *débris* extending to the river, a more minute account of which will be given by Professor Hawn. The first mountain on this side, leaving the park, appeared to be granite, then, for a distance of a mile, trap and porphyry, beyond this, to about half a mile below the fork of the river, the appearance was unusual, a rich red, almost crimson-colored, quartzose, similar to the diamond-bearing strata of Central India. On the left bank the mountains were of a softer outline, sparsely timbered to their visible summits, which were generally from 1,000 to 1,500 feet above our trail. Our camp, No. 1, was situated about 1,000 feet above the forking of the river, and about half a mile below the bluff which split the valley. From Hamilton Park to this point we found a faint miners' trail, but above here the trail gave out. The north fork of Mineral Creek lies in the same general direction as the main river below the junction, and this was the one first examined. Almost immediately on leaving camp we entered dense and very heavy pine-timber, much larger than any yet seen by the expedition; many trees had fallen, and their trunks lying in all directions over the boggy ground made progress slow and fatiguing. One tree was estimated by me to have a diameter of 38 or 40 inches, about a foot above the surface of the ground, and this was the largest that was seen. The timber ended at a point about a mile above the fork, and, while in it, little or nothing could be seen. On emerging we found ourselves on a very steep mountain-side, and at a height of about 300 feet above the river, which flowed through a V-shaped cañon, formed by slides from each side. About two miles above this the valley opened out into a small bleak-looking park, in which were a few clumps of stunted pines. This park, which I named Iceland, was about one-third of a mile wide and about half a mile long, of low, rolling divides between the numerous small streams that flowed from the mountains on the north side. As the day was far advanced, and we had a rough journey back to camp, I went no farther up this branch. Between the timber and Iceland Park the valley was very narrow, the creek a mass of foam at the bottom of the slide below our trail, the visible summits of the adjacent hills being about 1,000 feet above our trail on the south side, and about 800 on the north side. Immediately above the timber, on the north side, were high, precipitous cliffs, and it is to the shelter afforded by these that I attribute the thrifty growth of vegetation at this spot. The following day we ascended the south fork. The general appearance of the country was totally unlike that found on the north fork, or, indeed, of any of the streams flowing into the Animas which we have examined. From the fork the mountains rise very suddenly on either hand, leaving a comparatively wide, swampy bottom. This bottom will average 500 feet in width for about three miles to the triangular valley lying between the feet of Red Mountain, Mount Flatface, and the mountain on the right bank of the creek, and the tributary which here falls into it. This valley measures about 2,000 feet on each side of the triangle, with a nearly level water-worn pebble and small bowlder bottom, on which there is an open growth of willows in patches, the main stream running close to the foot of Red Mountain under a high precipice of beautifully colored and stratified red sandstone. The sheer face of the precipice was estimated to be about 800 feet, and it had a slope of *débris* about 300 feet height to the stream. The west side of the valley was bounded by the slope at the foot of the enormous precipice to which the name of Flatface was given. The slope appeared to be at an angle of about 40°, with the horizon rising to a height of about 800 feet, where it meets the precipice, which, at a moderate estimate, is at least 1,500 feet in height. A tributary 25 feet wide by about 15 inches deep flows from the northwest apex of the triangle along the foot of the slope to Flatface. The mountain on the third side of the valley is steep and rocky, but not precipitous. The slope at the foot of Red Mountain is nearly bare, while the slope of Flatface is covered by a thick growth of gigantic pines. The river plows through a V-shaped cañon, between Flatface and Red Mountain, and our trail was through the timber about 600 yards on the slope of Flatface. Above we found a very steep-sided V-shaped valley, the visible summits of the mountains on the east or right bank being about 2,000 feet above the river, bare and rocky, but sloped to the stream; on the left or west bank the slope was about two in one—so steep that with difficulty our mules kept their footing; this slope was covered with bold precipices, commencing at Flatface, and gradually becoming less and less high as the valley rose, averaging 600 or 700 feet, their visible summits being about 1,400 or 1,500 feet above the river. At the upper end of this valley the river ran under an almost continual bridge of snow, and snow was seen in patches at the level of our trail on the opposite side. At a distance of about two miles above the triangular valley described the whole scene was duplicated on a somewhat smaller scale and bleaker aspect, minus the timber and the precipices of Red Mountain. The mountain which here blocked the valley, and which we named Bareface, had the same general appearance as Flatface, plus some extra snow, and the stream was here forked, but owing to the steepness of the trail, and the obstructions caused by the melting snow, we turned back after taking the bearings of the streams. In this valley the river has formed for itself a very regular bed of bowlders, built into the shape of a V, about 50 feet deep, and in perfectly straight reaches. The following morning camp was struck, and the party returned to Camp 26, main line, from which Cement Creek was ascended.

*Cement Creek.*—The entrance to the valley of Cement Creek from Hamilton Park was about 300 yards north of Camp 26, and is very narrow; the hills on the left bank being low, the trail leads over their face at a distance of from 300 to 400 feet from the river, which is here about fifty feet wide and two deep, very swift; the water of a peculiar light-brown or dirty-white tint, owing to its holding in solution a mineral salt, which has the property of firmly cementing together all the pebbles in its bed, which characteristic makes it a dangerous stream to ford when it passes over bed-rock, as it fills all the interstices, making the bottom of the stream perfectly smooth, thus affording no footing to enable animals to withstand the swift current. The general appearance of the valley in its lower course is that of most of these mountain-streams, the mountain slopes being rather softer and more thickly overgrown with spruce, pine, and aspen, than usual in this region. The mountain-slopes come down to the stream, having slides from 20 to 400 feet high where the stream washed against them, and small, narrow, swampy bottoms, sometimes grassed, sometimes covered with willows, and often with spruce-pine.

The sky-line on the side opposite the trail is generally seen at a height of from 1,200 to 1,500 feet, the snow-range being seen occasionally up the valleys of the tributaries at a distance of from half a mile to two miles. About two miles from the park there is a break in the mountains on the right bank, forming a broken, irregular, steep valley, down which come several torrents, on one of which is a fine cascade. In this valley and neighborhood are many mining claims, and thus far there is a faint trail, but beyond we have to make our own. Long sights were generally obtained, but progress was slow, as traveling was very difficult over the fallen timber on the slopes and in the marshy bottom. Our Camp No. 2 was at a point five miles above Camp 26, main line, where the timber becomes more scant, extending continuously but a short distance up the slope over the stream. About a mile down this camp on the right bank is Matilda Creek, a small brook on which is the mine of that name, said to be valuable. About three-fourths of a mile beyond this, the stream forked, the main body of water coming from the west fork, up which our line was taken. Both forks rise rapidly, and were crossed by numerous snow-bridges June 19. Above the forks the timber is confined to sheltered places, and on the west fork there is very little. A mile above the fork, the snow-swamps were so deep and traveling so difficult the line was stopped, bearings being taken to a mountain which headed the valley, about half a mile beyond.

We returned to Camp 26 on June 20, and started line toward Bowlder Creek, the trail up which was found to be too rough for ascent by mules, and it not being of any length, the ascent was deferred. The line was then carried across the Animas just below the mouth of Little Giant Creek, where the river at the bottom of a cañon 100 feet deep was about 100 feet wide, up to the girths of the mules. This line was run to the settlement of the Little Giant Company, (to be seen from our main trail,) and subsequently up the mountain to nearly its source. Little Giant Gulch may be described as a huge land-slide or bite out of the mountain, down the center of which the creek has worn itself a deep box-cañon. Little Giant Creek, a branch, up which the line was run to snow, in no way differs from any of the numerous torrents in the neighborhood.

## EUREKA GULCH.

The line up this gulch was started from the extremity of the line previously run up the main valley by Mr. Bassel. The entrance into this gulch is very peculiar. Through a densely-timbered cleft in the mountain a large stream issues from a deep cañon, the end of which is turned to the main valley. The wall on the left bank of the creek is surrounded by a very steep, rocky slope; that on the right bank by a less steep and densely timbered slope of earth and *débris*. A point at the mouth of the cañon on this side is about 280 feet above the river. From this point a surprising and charming view is obtained; from a point in the gorge about 200 feet away and 30 feet lower level the creek plunges in three leaps into a pool 150 feet straight below the spectator, and thence in a series of minor cascades to nearly the level of the Animas, issuing from the cleft about 100 yards below, a broad, sprawling, rather slow stream of a totally different appearance. From the foot of the slope leading into the valley from that of the Animas for a distance of half a mile, the trail is in dense timber and rises rapidly, being at this point about 500 feet above the Animas River at junction.

Here the general appearance of the valley is a deep V, the visible sky-lines being about 800 to 1,000 feet above the river; on the right bank the slope is continuous from the river to sky-line; on the left bank the slope is surmounted by cliffs of about 400 feet where we leave timber, but becoming less high as the valley is ascended. It in no wise differs in general appearance from the upper part of Cement Creek or of any of the higher mountain valleys. The line was run for about three miles above its junction with the Animas, where the mountain side was so steep and difficult to travel over the slide rock that it was deemed inadvisable to proceed farther.

An attempt was made to ascend Maggie's Gulch, but was abandoned, as the stream was swollen with melting snow, and the only practicable trail is along the creek-bottom, sometimes up the middle of the stream.

The line was carried to a point about half a mile from its junction with the Animas, from whence bearings were taken, and the distances estimated as far as could be seen up the nearly straight lower reach. The mountain sides on either hand, for a distance of about a mile, are steep stone slides of from 400 to 600 feet, impassible along their face for man or animal.

E. W. CAMPBELL,
*Recorder.*

*Camp 26, down the Animas.*—About a mile and three-quarters below Camp 26 the trail leaves the Hamilton Park and enters the cañon of the Animas. The trail at once ascends directly up the face of the hill on the right bank to about 200 feet above the river valley, then turns southerly along the face of the mountain, and rises rapidly, Camp 27 being 1,030 feet above Camp 26, and distant three miles from it. For 1,000 feet the trail skirts the face of the precipice, and is very dangerous, being narrow, crooked, and steep. A heavily-packed mule might easily roll down 300 feet on the sharp rocks below; we passed without accident. After this precipice is passed the trail passes into small sprucepine, and on to mossy, vegetable-soil-covered rocks, and is no longer dangerous, but steep. Many snow-banks lie in the pines, but are avoidable or not deep; water and wood plentiful, but grass poor. A short distance below Camp 27 I went down the cañon of a small creek until the Animas River was seen, at a distance of about one-third of a mile and 500 feet below. A small aneroid barometer carried indicated the same height at Camp 27 at the crossing of the trail and this creek, and a descent of 945 feet from the crossing to the point where I saw the Animas, at an estimated depth of 500 feet below me, thus making Camp 27 to be at an elevation of about 1,445 feet above the river. The cañon of the Animas, at the mouth of this creek, is not less than 3,500 feet deep on the east and 1,445 feet on the west side, and consists of ledges of trap or basaltic rocks covered with a thin, small growth of sprucepines. It is impassable for pack or saddle animals.

The cañon of the creek down which I went is about 500 feet deep on the north side, 200 feet of which is a sheer cliff of ragged syenitic granite, crowned by a steep slope bearing a few pines. The south side is much the same, the cliff being of less height. Through this cañon the water rushes in an uninterrupted succession of cascades, so that it is but a stream of white foam. At the point where I read the barometer it was 150 feet below me.

Our guide was of opinion that the mountains immediately east of the Animas, at this point, were a spur from the main range, and that east of this spur a stream rises, which empties into the Animas below. West of Camp 27 is a sharp peak with a crown, the summit distant about one mile. South of Camp 27 is a divide between the waters flowing east and those flowing south. About two miles from Camp 27 we passed a small lake frozen completely over, (June 15,) and a mile and a half beyond this another one on the divide.

*Fountain and Diana Creeks.*—Thence the trail followed the valley of Fountain Creek to Camp 28. The trail from Camp 27 to Camp 28 was through small spruce-pine, with open, swampy glades grown with scrub-willows. These glades are soft, but not so much so as to be troublesome if care be used.

No camping-ground from Camp 27 to a point about one mile above 28; thence abandoned of wood, water, and good grass. The trail from Camp 28 is through three and a half miles of heavy spruce and pine timber to Camp 29, on a small stream and pond about two miles from the base of Engineer Mountain, and northeast therefrom. Trail steep and marshy in places, but not dangerous. No grass from 28 to 29, but wood, water, and fair grass at 29.

*Ascent of Engineer Mountain.*—From Camp 29 I made an ascent of Engineer Mountain, leaving camp at 1 p. m. Ascent rapid until I had attained a height of 1,000 feet, where I found large timber full of solid snow, 4 or 5 feet deep. Walked on this snow for three-quarters of a mile, (leaving the timber at a height of about 1,350 feet above camp,) rising about 600 feet to the crest of a limestone ledge, having a vertical wall of 150 feet at highest point. The stratum, dipping rapidly to the southwest, is covered with soil bearing the stunted willows found on Hamilton Pass, and a few stunted pines. Much soft snow on this plateau, on gaining which the peak of Engineer Mountain suddenly appears before me, south 65 west, distant one mile and three-quarters, and about 1,000 feet above me. This peak is a long, narrow crest, and I saw it first precisely in the line of its long axis. Seen thus, it presents a conical base of earth and *débris* of about 200 feet height; above this a vertical cliff of gray red sandstone, 200 feet; a cliff of dark red slate, about 10 feet; a cliff of from 50 to 200 feet of a light gray rock, and above this a sharp cone of the same color, 600 to 800 feet high, crowned with snow. Although it was then 3 p. m., I determined to ascend this peak, and made my way to the base, sinking mid-thigh deep in the soft snow every third step. The slope of the northeast end was comparatively easy, (that is, as steep as loose rock and soil will lie,) and I ascended that. At the top of this slope I found a stratum of grayish red sandstone, and above this a stratum ten feet thick of dark red slate, on which was the crowning stratum of light gray. These strata slope rapidly down north 65 west, in the direction of the trend of the crest, so that at the northwest end of the crest, for about three-quarters of a mile, only the upper stratum of light gray rock is exposed. I mounted above the slate with no other difficulty than fatigue, but above this was my work. I found the peak to be shaped like a saw-tooth, the laminæ of the crowning stratum vertical, and the northern face a sheer cliff of about 1,000 feet, absolutely vertical; the south face also a sheer cliff of about 500 feet, crowned with a slope of *débris* as steep as *débris* can stand, the faces meeting in an edge of not more than ten feet in its greatest width, oftener of no perceptible width. From both faces occasional vertical laminæ stand out at right angles with the long axis of the crest, forming wings and buttresses surrounded by sharp spires.

The only possible ascent is up the edge, which slopes rapidly at both ends of the peak down to the top of the slate. The feelings of a solitary man toiling on hands and knees up this edge are not cheerful. A huge stone suddenly gives way, falls over the north face, and after a painful interval, during which the climber, with bleeding finger-tips, struggles for a few minutes' more life, is heard crushing among the rocks, and directly afterward is seen spinning far out on the plateau below across the snow, throwing it high in the air; or a loose rock yields on the south side, thunders down the slope and leaps over the precipice, followed for minutes by an avalanche of *débris.* How grateful I was for the occasional snow-banks piled against the southern face, which gave now and again an opportunity to stretch myself at full length and breathe. I reached the summit at 4.30 p. m., and was rewarded by the grandest mountain view I had ever seen. In every direction, except down the valley of the Animas to the south, were seen masses of snow-peaks rising a thousand and two thousand feet above timber, with sky-lines marvelously bold and wild. These peaks were seen at distances of ten to thirty miles around. I doubt if any other mountain region in the world displays so extensive a mass of such increasing variety of form and so wholly grand. The peaks are of all conceivable forms, except such as have curved lines, all snow-crowned, furrowed by deep gorges, marked by the low-reaching streaks of snow, and flanked with spires and pinnacles. Below the timber the lines become soft, and the masses of dark pines are relieved by the white threads of foaming mountain-torrents.

Down the valley of the Lower Animas appeared open glades beautifully green, dotted with small pools, and aspens just in the tender green of early spring. This was the first spring foliage I had seen that season, and was refreshing after weeks of snow and pines. I could trace the course of Fountain, Diana, and Cascade Creeks from their sources to their mouths, with many of their branches. West of Cascade Creek and north of Diana Creek appeared the head-waters of two other streams, a fork of Mineral Creek north, and an unknown creek west.

*End of ascent of Engineer Mountain.*—From the readings of a pocket barometer the height of this peak was found to be 3,335 feet above Camp 29, or about 13,270 feet above the sea.

About a mile southwest of Camp 29, the trail passes the summit of a low divide, on to a southern slope, and almost immediately we passed from winter to advanced spring, descending rapidly in an exquisite valley of a small tributary of Cascade Creek.

*Cascade Creek.*—On either side the slopes of the hills were covered by aspens in the tender green of spring, and the open glades were bright with grass and wild flowers in bloom, among which were purple and white violets, strawberries, larkspur, buttercups, *fleur de lis,* and many delicate flowers unknown to me. For most of us this was the first glimpse of spring, having come into the high country of the Upper Rio Grande while it was still brown from the autumn and winter, and passed quickly up among the rocks, snow, and pines, and after weeks of grand desolation we passed in an hour into this most lovely valley of bloom and verdure.

Camp 30 was situated on the left bank of Cascade Creek, where our trail crossed that stream, a roaring mountain-torrent about 4 feet deep at its maximum, which occurs between 8 and 10 p. m. About a quarter of a mile below the camp the stream enters a cañon 150 feet deep, having vertical limestone walls just far enough apart to allow the water to pass.

This "Box" Cañon is about half a mile long and very crooked, the creek wearing smooth rounded hollows under the cliff, as it passes from side to side. Considerable difficulty was experienced in fording this stream, which was done at 10 a. m., when the water was lowest. The animals were crossed singly, with lariats attached, and the more valuable packages were carried by hand over a log bridge. From Camp 30 to Camp 31 the trail was in a beautiful valley all the way, but little timber on the trail, a few soft places presenting no great difficulty to pack-trains.

From Camp 31 to 32 the trail was plain and easy. On the right, close to the trail, were limestone bluffs 200 to 300 feet high, being the eastern edge of a mesa or steppe which was overlooked by another similar bluff. The trail is on another mesa, sloping gently toward the east and ending at a low pine-covered limestone ridge, which separates the mesa from one below it of a similar shape, terminating at a ridge of extremely hard crystalline rock. At the foot of the mesa on which the trail runs, and close to the limestone ridge, are many small lakes. Near Camp 32 this mesa is about one mile wide and gradually narrows, finally disappearing at the head of the park. Trail descended abruptly into the Animas bottom, which at Camp 32 is about one mile wide, one-quarter on the west and three-quarters on the east of the river, which here comes out of its cañon, at this point only a low, rocky gorge through a throat of quartzite, which is about 30 feet above the water, 500 feet long and only from 15 to 30 feet wide, through which the water rushes with great depth and velocity. We descended on the march from Camp 31 to 32 over 2,000 feet, passing from spring to midsummer. I never had a more delightful morning ride. Birds sang in the trees, and flowers blossomed everywhere in the green glades and thickets.

A short distance from Camp 31 we came to cottonwoods and large willows, and shrubs of oak, maple, cherry, service-berry, and some unknown varieties. The oaks gradually came to be about 25 feet high, none greater, and, about three miles above Camp 31 we struck yellow pine of grand size and first-rate quality. There is much of this large yellow pine, not in forests but scattered over the mesa. We constantly passed thickets of roses in full bloom, and also found in flower cherry, service-berry, elder, flax, daisies, plums, sunflowers, coreopsis, the common male fern, cacti, and many others. Evidently the whole region, from two miles north of Cascade Creek to the head of the Animas Park, is fertile and warm enough for valuable agriculture. Grass is everywhere luxuriant.

*Animas Park.*—From Camp 32 to Camp 33 the trail is all the way in the Animas Park. The Animas Park is about 13 miles in length by an average width of a mile and a half, the greater portion on the western side of the river, and having its axis in a south-southwest and north-northeast direction, ending at its southern extremity in a sort of pouch, called by Mexicans the Rincon. The mountains at mouth of Upper Cañon, where the river debouches, have sunk to foot-hills of 1,000 to 1,500 feet above the valley, sparsly timbered to summit. On the east of the peak the range continues all the way to the "old Spanish trail" at a height of about 2,000 feet above the valley, exposing the strata of a brilliant red sandstone in many places.

About the middle of the valley these strata are exposed from base to summit for a mile or more and are very beautiful. They slope to the south at an angle with the horizon of about 20°, are perfectly parallel, and from 20 to 50 feet from stratum to stratum. Each stratum is a sheer cliff, somewhat columnar for three-quarters of its height, with horizontal laminæ across the tops of the columns, looking like exquisite architecture. On the top of each stratum is a narrow terrace covered with verdure; back of this another cliff rises, and so on to the summit. The colors are vivid red and green, and the whole as symmetrical as the work of the most careful architect.

Toward the south end of the park, the red sandstone has dipped below the soil and covered with a gray sandstone. These eastern mountains are of a singular shape, having rectangular lines, and slopes like the frustra of pyramids. South of the " old Spanish trail" the eastern hills have conical curves on the face, while the summit is one line sloping toward the south, at an angle of about 10° with the horizon. Their face is thinly timbered with quaking-aspen. The western boundary of the park is a high range of sandstone cliffs, 1,500 to 2,000 feet above the valley, dipping toward the south, and is a counterpart of the eastern range, except that the red sandstone is not so well exposed. The limestone cliffs seen on the right, before reaching the park, disappears shortly below Camp 32, about a mile, running out above the sandstone. The gorge of the Animas above the head of the park is through a stratum of feldspathic granite, in which occur remarkably large crystals of feldspar. This extends along the river as far as we could trace it. The bottom looks fertile and is well watered, even swampy in places. In the northern end is much fine yellow pine, particularly on the east bank about the ruins of the Animas City. These yellow pines are scattered all down the park. Along the streams are some small cottonwoods and sweet gum, and many rose and service bushes. On the dry ridge we found low, white sage, grease-wood, and cacti, the latter in bloom with brilliant pink, crimson, and purple and yellow blossoms. About half way down the valley a small stream flows down over the sandstone cliff, making a pretty cascade of 20 feet or thereabouts, falling in threads and rivulets.

It then flows down toward the river through a thicket of willows, gums, and roses. The Rincon is a slight enlargement of the park about three miles wide.

In the east it is closed in by the range described south of the old Spanish trail, in the south by a range of about 2,000 feet above the river, of rounded outlines timbered to summit, probably sandstone.

*Mountains at south end of Animas Park.*—This range continues on the south and west of Animas as far as seen. This range breaks down at a creek by which the South La Plata trail passes out; between this pass and the North La Plata trail, over sharp mountains of sandstone and shale, about 1,000 to 2,000 feet high. These probably extend back to the La Plata Mountains.

The park is fertile, level, and well watered with several small streams. There is little timber—cottonwood and large yellow pines in the bottom, and spruce-pines on the mountain slopes. The Rincon is more rolling, low sandy hills, with much sage and cacti and little grass.

*Camp* 33 is on a small creek called Junction Creek, because of the junction with various trails.

*Trails entering Animas Park.*—Four great trails center in the Rincon: the old Spanish, from Pagosa, coming in northeast down a gulch crossing the Animas three-fourths of a mile above Camp 33; the lower trail, from Pagosa, coming up the Animas; the Lower La Plata trail, passing out through the gulch of a small stream; and Upper La Plata trail, passing out up Junction Creek for two and a half miles, then turning to the left over the hills, said to be ten or twelve miles to the La Plata. Lower La Plata and the old Spanish trails most used now. La Plata Mountains are seen through a gorge of Junction Creek. Animas passes down a valley of a quarter of a mile wide, so far as seen, in a southeasterly course. The La Plata Mountains, as seen from here through the gorge of Junction Creek, are rugged, timberless, snowy peaks.

*Mineral springs.*—In the top of Animas Park, near Camp 32, are several mineral springs of remarkably pleasant taste. Evidently they contain carbonic acid, and perhaps some salt of soda, and certainly sulphur. The odor of sulphur was strong, and flour of sulphur was seen in small quantities about them. The deposit is extensive and of a dirty yellowish-white. Many old mounds are seen of now extinct springs. Upon our return to Baker's Park I found that a reported Indian outbreak on the Cucharas had caused an order to be issued for the immediate return of the escort.

*Origin and beginning of Prout's scout to Lake Fork of Gunnison.*—As this threatened to prevent our making any examination of the Lake Fork of the Gunnison, I determined to make an effort at this examination by a rapid reconnaissance from Baker's Park over the divide to the head of the Lake Fork and down it, overtaking the party on the Rio Grande. Accordingly I turned the party over to Mr. Bassel, with instructions to complete the survey of Baker's Park, to give Mr. Hine time and facilities for photography, and to try to camp in Antelope Park by the night of the 28th instant, and await me there. Procured rations of Mr. Hamilton, took Frank Sager and Jack Monroe and one pack-mule and started at 10 a. m. up the Animas. Began topographical sketch at Eureka Gulch, rose rapidly between mountains of which the visible crests were 1,500 to 2,000 feet above the river. Now and then a high peak could be seen. Many small streams fall over the cliffs on either side in beautiful cascades; the cliffs seemed to be of trap and basalt, exceedingly wild and rugged. The mountains soon open out and give a valley, narrow and with a few spruce-trees; up to this point the trail is very bad with slide rock, but from here to the summit it passes on grassy slopes. In many places the river was still hedged with snow and the land wore the appearance of early spring. Made a noon-camp at the forks of the Animas. Here the trail turns abruptly to the right, and rises very rapidly on a grassy mountain-side, up to the East Fork. The Animas below the forks is about 15 feet wide, 1 to 3 feet deep, rocky and very rapid. The East Fork is 4 or 5 feet wide and carries little water. The western and middle one larger, the western being the largest. These forks all head in snowy mountains, in fair-looking passes, against corresponding tributaries of the Uncompahgre and Grand. The pass of the East Fork from the Animas side is extremely steep but hard and grassy to the top. Little snow on this slope. At the summit on either side are immense peaks of ferruginous quartz, trap, porphyry (red and green) and granite, so mingled that it was impossible to arrive at any general law for the distribution of these rocks.

*Pass to the Lake Fork.*—The mountains northwest of the pass in which the middle fork heads are the Uncompahgres. Those south are a spur of the main range continued from the range which bends around the Rio Grande. From the summit of the pass one looks down the Lake Fork of the Grand for three miles.

*View from the summit.*—The view is supremely grand. On either hand rise close above the stream gigantic peaks far above any vegetation—bare crags with immense bodies of snow in the deep gulches. From these gulches flow numerous small snow-streams. This pass, like all summits in this region, is a knife-edge.

*The descent to the east.*—The descent is steeper and far more difficult than the ascent. There was much very deep snow which fortunately bore the animals and bridged many gorges which would make the pass nearly impracticable without the snow. The timber-line was higher than on the Animas side, and we soon began to pass through groves of finer spruce than I have seen on any other slope in this region, and over glades of tall fresh grass, spangled with many wild flowers. The willows, which here, as elsewhere, are the highest vegetation, were just opening their leaf-buds; buttercups were among the highest wild flowers seen. We descended about two miles on snow-bridges and over rugged slopes to a small park—Mountain Park. Looking back toward the heads of the streams which come into the park, the peaks of the Uncompahgre and of the main range presented singularly wild and grand sky-lines against the perfect June sky. They presented no soft lines or angles, but all terminated in sharp crags, crests, and spurs. In many places their thin edges of snow curled over the crests, through which the sun shone with a soft glow into the chasms below, an effect which I had never before seen and which was strange and weird. We camped by a soft spring at the bottom of the park; wood and water; march about 15 miles.

Lake Fork is here about 30 feet wide and 1 to 2 feet deep. Snare Creek and Delusion Park, so named because in coming in sight of them after our tedious and difficult march through fallen timber above the cañon it seemed as if we were about to descend into Paradise, and instead we found a delusion. The Park extends four miles; a bottom thickly grown with willows and brush, and often miry. There are some small glades of fair grass, and considerable pretty good timber, spruce and cottonwood. After leaving the park had frequent views of the great peaks of the main range, 3 to 5 miles to the right. After this saw occasionally the great peaks of the Uncompahgre, (our past topography.) Just before reaching the park, on either hand, are high, bald crags, cliffs, and slides. From the slides they seem to be syenite granite, porphyry and trap, the two first in great preponderance and with fine crystals, hard and compact. We cross the stream just as it enters a cañon, and our trail runs along the mountain-side from 200 to 600 feet above the river and is exceedingly difficult.

There is much fallen timber, and the slope is as steep as it can be and holds a thin soil; of vegetation scant. At the exit of the stream from the cañon the latter is 300 or 400 feet deep; at one point seems no more than 20 feet broad, and probably is not more than 50. The width seems less at the bottom than the top. At the crossing the stream is 40 feet wide and 1 foot deep, swift; small bowlders at this point; aspens run up east slope 1,000 feet; spruce 400 feet farther; all small and much windfall.

East slope here becomes craggy and furrowed with deep gulches. Mountains slope to stream on each side; on east 500 or 800 feet of very steep grass slope, with a little aspen above on the west; rugged cliffs and slides. After leaving the park the stream enters a narrow box cañon 10 to 30 feet deep, where the mountains close in again for half a mile. Below this commences another such valley as above, through the willows and mire of which the trail is difficult. The mountains on the east of Delusion Park, for two-thirds of the distance down, are mostly bare excepting the lower mile, where timber appears nearly to the visible crest, which is not the summit. On the west the mountains are timbered to the summit below Snare Creek, and show rock only occasionally, or rather timbered to the visible verge. The lower third of the park on the west seems to consist of trappean or basaltic rocks. Those on the east, however, seem granitic, but with larger crystals and more feldspar, and show greater tendency to disintegrate. Range about the same distance to the left.

The mountains seem close at hand, more timbered, and now show their rocks exceptionally, evidently also more basaltic and much more trap. There is no more bottom-land until reaching the lake, but the valley is filled with low hills and ridges. The stream then passes through a cañon 50 to 150 feet deep, with vertical walls one-fourth of a mile long. Below this cañon the mountains open out and form a valley almost entirely filled by a lake two and a half miles long by three-fourths wide. After crossing to the west side above the lake, had about 1,500 feet of willows, 8 to 10 feet high, and bottom extremely soft; animals mired to their bodies at every step. Then passed through a grove of yellow pines and down the west side of the lake on the slope of the mountain. This lake is a beauty. Its waters are perfectly clear, and reflected the mountains which slope into the lake on all sides. It has numerous coves and reaches, and two or three little islands dot its surface. Ducks, teal, mallards, and mud-hens were seen in all the coves with their broods of young, while a flock of ambitious mallards were sailing down the middle of the lake. There are no fish. Immediately below the lake begins the great land-slide, to be described hereafter. Crossed about a mile below the lake. Stream here 70 feet wide, 4 feet deep at most, and very swift. Fortunately the bottom is not rough at this point, and by lariats animals were gotten over with no great difficulty. Camped immediately on east bank in a small alder thicket at foot of land-slide. Grass rank but coarse.

About one-fourth of a mile below this camp is the first fall of the Lake Fork, a very peculiar cascade. The stream, 60 feet wide, deep and swift, first plunges about 30 feet, strikes the face of a cliff, is deflected to the left nearly at right angles, plunges immediately about the same depth, is deflected to the right at a less angle, plunges immediately about 20 feet, and goes on its course as rapids. Thus the whole fall is 80 to 100 feet in a spiral cascade. Deep caverns are worn into the face of the cliffs as the water strikes them, and standing on that, below the first leap, one is within 20 or 30 feet of the crest. The whole spiral is one mass of foam. The cliffs seem a shaly trap or other rock of the trap kind, dark and extremely hard. From this point the scout was further continued down the Lake Fork some distance, but as the topography will be described in a succeeding portion it is here omitted.

Upon retracing the route, we struck south from Lake San Cristobal, and reached Antelope Park, meeting Mr. Bassel and the party just entering from the Rio Grande. That night we received news that the reconnaissance would be continued according to the original schedule, the Indian troubles having turned out to be of little consequence.

Provisions were received to last the party while making the examination of the Lake Fork, and immediate arrangements were made to commence the trip. Connection was made with our outward line near Camp 17.

*Examination of the Lake Fork.*—On our return, Camp No. 40 was made on the site of Camp No. 17, and Camp 41 on the eastern side of Bristol Head, about two miles south of Camp 18. Thence, on our march to the Lake Fork of Grand River, our trail diverged from that before described at the southern apex of Bristol Head, where we passed up a dry cañon close to the precipitous face of the mountain, which we named Lake

Cañon, as we found a lovely lake on it, which we named Lake Mary, at the northern end of which we made Camp 42.

*Lake Cañon.*—Lake Cañon is about seven miles long and half a mile maximum width, its long axis in a nearly true northwest and southeast line. The eastern wall is the face of Bristol Head, and the western wall the face of a range of gently rolling hills which gradually fall in the southwest to the level of Antelope Park, and vertical on their northeast face. Evidently these hills were once the end of the spur cut off by some process of nature. Both the faces are vertical, and generally of a coarse conglomerate composed of rounded water-worn pebbles and bowlders, imbedded in and rounded by a material which has the appearance of dry sandy clay. In the valley are many enormous bowlders of this conglomerate, which have taken fantastic shapes, piled in and overhanging the little lake. The eastern wall reaches a height of over 2,500 feet, as deduced by barometrical readings, about 1,800 or 2,000 feet of which is vertical cliff; below this is a steep slope of rocky *débris*, with a thin soil, and spruce timber. This cliff is very grand. All along the face of it are towers and pinnacles, few of them rising to appear in the sky-line, but generally projected against the face of the cliff, giving wonderful lights and shadows.

These spires are often connected for long distances at their bases, then rise sharply from the mass below, like the myriad pinnacles of Milan Cathedral; sometimes in groups, and again one solitary spire will rise from the base of the cliff to its summit. Great buttresses spring from far out in the valley, and along the crest are here and there jagged rocks like battlements.

*Lake Mary.*—Lake Mary is a lovely little sheet of water, about two and a quarter miles long, and a quarter to a third of a mile wide, dotted by many wooded islets, overhung by woods on its steeper western bank, and covered by flocks of wild fowl. Many picturesque works under the nooks on the western shore, from which charming views of the lake and great mountain precipices are obtainable.

While encamped on Lake Mary a fire caught in the long grass from our cook's fire. A high wind was blowing down the cañon, and, although vigorously fought, the fire soon obtained the mastery, and swept through the camp of the escort. No serious damage was done, however. A corporal and private were sent back to Camp Loma for a supply of blankets, &c., to replace those lost by fire, and were directed to overtake us on the Lake Fork while we continued our march toward the pass.

*Clear Creek Falls and Cañon.*—About three miles from Lake Mary we passed into the valley of Clear Creek, and six miles from Camp 42 we came to the cañon and falls of Clear Creek. This cañon is apparently about three-quarters of a mile long, ox-bow shaped, west, south, and east nearly, from 50 to 100 feet deep, basaltic sides, opening out wide at top and shelving toward bottom. It opens out in the plain, and through it the waters of Clear Creek pass to the plain below. At the upper end of the cañon is a water-fall of about one hundred feet, in four cascades. The stream being about 10 or 12 feet wide at brink of the fall, which was stated by our guide to be lower than he had ever before seen it. About a mile and a half above the falls we crossed the great Ute trail from Cochetopa toward the country south of the Sierra La Plata. This is the trail crossed on our ascent of the Rio Grande, and the one followed by me on return from Lake Fork scout toward Franklin's ranch, until the trail turned up mountain. The whole country, from upper end of Antelope Park to pass, and between mountains of main range on either side of the valley, is a magnificent cattle-range. Tall grass, much aspen and spruce up the valleys of the small streams, with plenty of shelter and water. The whole region is one of rolling hills from the mountains on all sides.

*Pass from Clear Creek to Lake Fork.*—Our Camp 43 was on a small branch of Clear Creek, near its head, and the march from this camp to Camp 44 was over the summit of the main divide, approached from the eastern side by probably the easiest grade to the main divide in Southern Colorado. The summit was broad and level, and is the "high park" seen from the top of Bristol Head. From this summit an extensive view is obtained of the valleys heading in the Uncompahgre and main ranges. From the summit a first view of Mount Chauvenet was obtained—so called in honor of the late eminent professor of astronomy at Washington University, Saint Louis. It is probably the highest montain in this region and the grandest I had seen. The miners have sometimes called it the "Leaning Tower," and sometimes "Capitol" Mountain, from its appearance seen from different points of view. We nowhere saw it as the "Leaning Tower" of the miners, but our guide assured us that, seen from the west, its appearance is that of an immense tower toppling over. At this time it was covered with snow far down its side.

The summit of the pass was quite dry and free from snow at this time, but there were a few patches of snow and swampy places when I crossed it a few days before, returning from my scout to the head of Lake Fork. Our view in the direction of Upper Rio Grande and Lake Cañon was cut off by smoke from great fires. The region about the heads of the Rio Grande, Florida, San Miguel, Uncompahgre, Cebolla, Lake Fork, and Grand Rivers is of limited extent, perhaps 20 miles square, filled by a mass of snow-peaks in groups connected by crests, more or less high, from which the waters flow radially, and is probably the highest portion of the Rocky Mountains.

It is only by thorough reconnaissance that one can arrive at the truth regarding the sources and courses of these streams and the position of the peaks and spurs. The vertebral and rib system of putting in a stream and its tributaries is useless, as shown by the extremely erroneous maps of the Grand River and its tributaries. This region, like that of the Yellowstone Lake, seems to be one of the domes of the continent, as is shown by the fact that the same rivers which eventually flow west flow at first east and south, like Grand River and Lake Fork.

About a mile and a half beyond the divide we crossed a shallow valley, in which was a stream flowing northeast, one of the heads of Grand River, and at half a mile beyond this we crossed a second divide, on the northern slope of which was a dense growth of spruce and aspens.

About a mile below this second summit we made Camp 44, on a small open bench or glade, nearly opposite the southern end of Lake Cristobal. Thence the trail descends rapidly into the valley of Lake Fork, very steep and passing through the densest growth of small aspens yet met with. About a mile and a half below Camp 44, opposite the upper falls and near the north end of Lake Cristobal, we crossed an enormous land slide, which extends about a mile along the river by about two miles up a funnel-shaped gorge in the mountains, on the right bank, on the northern side of which is a tributary of the river.

The slide is composed of a bright yellow clay, soft in places, no grass or other vegetation on it except spruce-trees, many of large size and in their natural positions. Below the slide the descent is less rapid, and on a creek about three and one-half miles from Camp 44 we pass the "Scotland" mine, a claim which we were told was sold in Denver for

$30,000, now abandoned. This, with a few leads on Godman's Creek, said to run $500 per ton, are the only known leads in the lake mining-district, and these had only been worked for the claim. A few burros were seen, indicating presence of prospectors and some very old tracks on the trail, probably not more than six men in the district, and they prospecting.

*To Camp* 45.—From land-slide to Camp 45 trail good and plenty of grass; valley from a quarter to three-quarters of a mile wide, with rolling foot-hills and sparse growth of yellow pine, spruce, and aspen, having a truly charming appearance at the Lower Falls, where we made Camp 45.

On our march from Camp 44 to Camp 45, roses, cardinal flowers, larkspurs, daisies, gentians, Solomon's seal, and many other flowers were seen. Wild flowers are much more abundant and beautiful than on the eastern slope. In truth, the valleys of the Rio Grande and Arkansas, even up in Antelope Park on the Twin Lakes, is dry and barren compared with similar valleys on the Pacific Slope.

Lake Fork, especially above the Lower Falls, is a beautiful stream with abrupt rocky banks, flowing in dalles and cascades with a fringe of timber along most of its course; some fine photographs up and down the Lake Fork and lake were here made.

*The Lower Falls.*—The Lower Falls are very picturesque. The river flows very rapidly, confined in a gorge 30 feet wide, to the crest of the first plunge of about 25 feet; the stream then runs in a gorge, funnel-shaped, contracting to about 15 feet width at the crest of the main fall. Here it shoots out into the air and drops 60 feet; a clear fall into a deep wall-sided gorge below, about 150 feet long and 75 feet from surface of water to brink of rock above; below, these walls rapidly lower until they are but little above the stream. Immediately above and below the falls the cliffs at water-level are worn into deep and irregular caverns.

From the crest of the first leap to 50 feet down the gorge under the lower leap, the water is lashed to a snow-white foam of most lovely shapes, much like the Upper Fork of the Yellowstone. From the foot of the sheet, foam and spray rises high above walls of the cañon so as to wet my book as I sat above writing. Bright rainbows played about and over the cañon.

*Godman Creek.*—From Camp 45 I rode up Godman Creek for about three miles. Found it a deep gulch nearly east and west. The north face of this gulch is generally about 2,000 or 2,500 feet above the stream, of reddish gray trap, with much slide, sloping very sharply down to within 200 or 300 feet of stream, then ending in a vertical cliff. No soil or vegetation on this slope. Exposes deep furrows and sharp crests up and down the slope. The southern face is much the same, but holds a thin soil with scant timber and vegetation, thus making a trail possible. Went up this trail in search of miners and to learn about the reputed leads of this gulch. Found the trail steep, rocky, and very rough—a burro trail. There were on it some recent tracks of two or three burros, a man, and a dog. No further sign or trace of the miners of the lake district. These tracks were down the trail. My ride was terminated by a formidable gulch, which I did not think advisable to attempt with a mule.

Godman Creek is about half the size of the Lake Fork above their junction; wild and swift, its bright green waters flecked with foam, winding in cascades through its picturesque gorge.

*Camp 45 to* 46.—From Camp 45 down the valley the trail was very good except where the river was crossed, at which place the descent into the cañon was rather steep.

The valley is irregular in surface. The mountains on the left bank come close to the river; are mostly bare of soil. The slopes are very steep and rugged, with deep gulches and furrows, rugged crests and spires shooting up everywhere.

The width of the valley for a distance of nine miles below Camp 45 is nearly all on the right bank, the hills on this side having softened lines and rounded slopes. These hills break down at a point about four miles below Camp 45, exposing at a distance of from two to four miles what seem the summits of the Grand River Spur. The hills run down to the river in gentle undulations here and there, opening out into a small level park, are well grassed, watered by many small streams, and thinly covered with yellow pine. This pine is at largest 12 to 18 inches diameter, forty to sixty feet high. Here and there an old tree has escaped Indian knives and grown much larger. Growing in the open they are branched to the ground.

The trail is well worn, and the peeled trees show that the valley has been much frequented by Indians, but none of them had been peeled within a year or two. About six miles below Camp 45 the river enters a rocky cañon from 50 to 75 feet deep.

*Upper Cáñon of Lake Fork.*—At head of this cañon, Spire Creek comes in from the west. The walls of this cañon are composed of a light reddish-gray porphyritic trap much disintegrated, falling in steep slopes, through which slopes appear cylindrical columns crowned by sharp conical spires. Many conical surfaces of solid rock appear frequently through the *débris.* At the point where we crossed the stream the hills on the right had become rugged and ran down to the cañon just below the ford, rocky slopes with high jagged points and blades standing up everywhere, apparently a red porphyry and clinkstone. The valley-hills are now nearly covered with sand, sage-brush, and cacti.

From our ford to Camp 46 our trail was over a sage-brush-covered plain, and the camp was made near the slope of the mountain, about a mile from the river, in a swale with fine grass, plenty of wood, and scant water. River in a cañon about sixty feet deep, with no bottom-land whatever.

West of Camp 46 a valley opens out, up which a view is had for about three miles. A stream flows down this valley into the river, passing through a deep heavily-timbered cañon in front of our camp. Down this valley a well-worn trail came, making a junction with that down the Lake Fork about a mile below.

Below Camp 46 for about eight miles the valley presents the same general appearance.

*Great Gate.*—At this point we passed the Great Gate, a rift in a spur, sweeping around from range to range across the valley, curved concave up stream; all lines in present crest indicate this.

The "Gateway" is about 500 feet high and of basalt. The upper 50 to 200 feet is perpendicular cliff, below which slopes of huge sharp-angled rocks. The cliffs resemble the Palisades of the Hudson, columnar and regular, and it is similar to the spur and cañon above the lake. The valley must have formed a lake above this point, but no marks of water-benches are apparent, perhaps owing to the steep slopes having been rapidly washed down. Above the Gateway the cañon has gradually broken down until the river flows between steep-sloped gravel-banks of 30 or 40 feet height. Back from these, on either bank, are narrow sandy mesas covered with sage-brush and scant pine timber, broken by ridges, riven by arroyas, and often completely obliterated by descent of mountain-skirt.

Below the Great Gateway the valley suddenly opens out to a width varying from a quarter to three-quarters of a mile, the river running in a deep channel between gravel-bluffs 15 to 30 feet high. This valley, mostly sandy, and covered with sage-brush, having an occasional bit of river-bottom, moist, grassy, and bearing a few willows and cottonwoods.

These places were all cropped close by recent large Indian camps. The trail is now a broad double one, like a wagon-road, many trails coming into it from the mountains southwest, west, and northwest. About a mile and a half above Camp 47 was a large grassy flat with remains of a recent Indian camp of fifteen or twenty lodges. Here a trail crosses the river evidently toward the Los Pinos agency.

Immediately below this point the hills close to the river for a mile, the trail passing high up over bowlders on the hill-side.

Just above Camp 47 the hills suddenly recede, leaving a little park of irregular circular form half a mile across, the river running close to the western hills.

On both banks sky-lines and slopes have rounded washed lines, but steep; trap and basalt everywhere. Immediately below camp the river enters a cañon exceeding 2,000 feet in depth, extending to its junction with Grand River.

*Lower Cañon of Lake Fork.*—This cañon was not especially picturesque; the walls were exceedingly steep, rugged, and of a red hue, and the bottom so narrow that we were unable to run our stadia-line down it. The great Indian trail to the Uncompahgre Valley leaves the river above the cañon and runs farther west. We followed it for nearly two miles up the mountain-side until we reached the high table-land above. We then followed the general course of the Lake Fork for a distance of about four and a half miles at a distance of about a mile west of it. The country is very rough and broken, being intersected by numerous small streams flowing in rocky cañons, which become very deep and precipitous as they approach the river. The table-land extends west for about six miles, where it is broken by some low hills, and beyond these we could see some distant mountains. There was very little grass or timber where our line ran, the ground being covered with loose rocks, patches of sage-brush, and many wild flowers. West of our trail the surface of the country is more even, and there is also some timber and grass.

At the point where our line terminated we could overlook the Lake Fork and see in the distance a valley bounded by high mountains, running from the southeast to the northwest, which we supposed to be the valley of the Grand River. Its junction with the Lake Fork was judged to be at a distance of three miles, bearing N. 70 W. A little to the east of the point of junction is a break in the mountains to the north, appearing like the valley of a large stream coming in from that direction. The mountains in the northwest appeared to be low, compared with those on the north and east. Several small creeks were seen flowing into the Lake Fork from a high ridge of hills on the east, which ran parallel with the creek and distant about four miles from it, the intervening country being very rough and broken.

While at Camp 47 we were visited by many western Utes, mostly well armed, well mounted, and well dressed; uncommonly clean, smiling, and civil; short men, with broad muscular shoulders; good-looking for Indians; bland, courteous, and great beggars.

From Camp 47, toward Los Pinos agency, our trail, after crossing the river opposite our camp by a rather difficult ford, was up the valley of a small tributary flowing from the east-southeast, rising a thousand feet in about three miles, on to a broad rolling plateau about a mile and a half wide, with sparse spruce-pine and aspen, being the divide between the Lake Fork and another tributary of Grand River known to the Utes as "The Stream with the White Banks," named by us "Soda Creek," from a soda-spring found on its banks.

Camp 48 was situated in a swale just below the divide, on the head of a small tributary of Soda Creek. In one of the pine-trees at camp we found a humming-bird's nest with two eggs in it. The little bird was much disturbed by our arrival, but soon became reconciled to the unusual bustle and sat in her diminutive nest watching us with a bright suspicious eye. We fenced her in to protect her from our stock, and she was none the worse for our visit. About three miles from Camp 48 the trail entered the valley of Soda Creek, crossing a small tributary of that stream, which comes in from the south down a flat-bottomed valley. The valley of Soda Creek is about half a mile wide, level bottom, in some places marshy, stream fringed with willows. Our trail was up it for about three miles in a southeast direction. We then crossed the stream, (here about forty feet wide and about two feet deep; low flat banks, pebbly bottom, not very swift,) and turned east up the valley of a tributary. Ascent gradual for about two miles to a low divide between this and another and higher tributary of Soda Creek. Crossed the divide and made Camp 49 on last-mentioned creek.

The hills between Camps 48 and 49 are all barren, sage-covered, with sparse small piñon, spruce and aspen, good grass on margin of streams. Theodolite No. 5 was broken, and the plates bent, by a fall on the line between these camps.

From Camp 49 toward Camp 50 the course was for about two miles up the creek, the ascent being quite rapid. The slopes well grassed and sparsely timbered with small aspen and spruce; summit-level grassed plateau, one mile across, a considerable medium-sized spruce on either hand. Descended about half a mile into a pretty valley, with small stream flowing southwardly rising near Camp 50. From Camp 50 trail ascended for five miles by gentle slope on right bank of brook flowing west to a broad aspen-covered divide, and from this summit we descended about 600 feet in three miles to Camp 51, situated on a small tributary of the Los Pinos and distant about a mile from the Los Pinos agency. This slope was for the first half mile wide below summit very steep, remarkably well grassed all the way, and with many small aspens. At this camp we received visits from Agent Adams, Ouray, and several Ute chiefs.

The valley of Los Pinos is from one to two miles wide and six to eight long, northeast to southwest, surrounded by high rounded hills with considerable pine and spruce timber.

Valley bears excellent grass, but might have winters too cold for crops. Ration stock are grazed mostly at mouth of Grand and Cochetopa Rivers. Snow said to be 3 feet deep on an average level.

Agency consists of a good agent's house of pine-stuff, ceiled up with pine, and adobe fire-places very convenient; half a dozen employés' houses, with school and store-house. Indians come in early in May very hungry, and are fed during the summer, and in autumn go to the Uncompahgre region and lower agency for the winter. They have flour through the summer, have many goats, and good ponies. There is a saw and shingle mill at agency, which furnish lumber, &c., for all buildings and to sell.

Mr. Hine staid at the agency to get Indian pictures, rejoining us at this camp. He found them generally objecting to being photographed, often sulky and saucy.

From Camp 51 our trail was down the small stream, to near to its confluence with the Los Pinos, about three miles down the wide open marshy valley of the latter, which we crossed at a point where it is 15 feet wide by 1 deep. The Tumitchie was crossed at a point about three miles from our crossing of the Los Pinos, and at an elevation of about 700 feet above it. The Tumitchie is here about 30 feet wide by 2 feet deep, and sluggish, divided at the point of crossing into two channels, and flowing in a marshy bottom about one hundred yards wide between banks about 50 feet high. Thence up the valley of a dry tributary to a divide between it and a branch of Pass Creek, making Camp 52 at the timber on that creek.

No camping-ground between the valley of Los Pinos and this camp. Country broken by rounded mountain summits displaying red granite and porphyry in cliffs having thin soil and poor bunch-grass. The ascent is easy for wagons and possible for railroads.

From Camp 52 to 53 over the pass the trail is remarkably easy, ascending easily by the valleys of small tributaries of Cochetopa, over slopes grassed with bunch-grass and dotted with flowers, larkspur, foxglove, and many others.

The lines of hills are all soft, and all timbered with spruce and aspen. Beautiful open glades up the streams. The slope is very easy and entirely practicable for wagons.

We crossed the summit without knowing it, and only suspected the fact when the water was found running easterly.

*Saguache River.*—The descent into the Saguache is by equally easy grades. The country on the eastern slope is somewhat more rugged, but good grass and the same timber possibly smaller. Passed considerable pretty well grown pines. The creeks now begin to run in narrow rocky gorges of a soft coarse granite much disintegrated, and worn into very strange shapes. None of these gorges offer any obstacle to a wagon-road, but are formidable fortifications for the Utes in case of war.

On high hills on either side of the Saguache, and its branches, are seen great ledges of this granite rock in low slopes stretching along faces of mountains like great public works.

On a hill to the left just before debouching into the valley is a ledge with salient and re-entrant angles, a vertical face of perhaps 50 to 100 feet, and some embrasures for guns.

This approach to the Ute country is easy so long as no resistance is offered, but, as I have said, the natural position is extremely strong for defense.

At Camp 53 the country inside the inclosing mountain ranges of the Saguache Valley is a mass of sharp rugged foot-hills, little timber, and many deep gorges; otherwise it is a mesa country deeply cut with arroyas in the coarse granitic rock, these arroyas forming a maze not easily avoided. Below a small cañon the river-bottom widens out to one-half to one mile, and continues so to a ranch, where our road turns to the right from the river. This bottom is beautifully level and green, the grass being of excellent quality. The only wood is the fringe of black alders and willows along the stream.

The mountains, except the snow-peaks, are timbered ranges of soft, long slopes with nearly level sky-lines. The mesa country is arid and barren, with some cacti and sage. At the point of turning to the right we pass into foot-hills, rugged and sterile, and of porphyry and coarse granite. So far as seen the mesas have disappeared; some spruce and cedar on the hills, but most of the timber is piñon. On the crest of the cliff over Camp 53 I found a line of small crescent-shaped rifle-pits, of loose stones piled up to one or two feet, so placed as to command the bottom, and more especially the mouth, of the cañon through which our trail comes in. This whole valley is said to have been an old stronghold of the Utes against the plains Indians, Kiowas, Comanches, &c. Marched about fourteen miles and made Camp 54, in a clump of cottonwoods on a brook; poor grass; no rain yet on eastern slope.

The whole region about Camp 54 is a mass of hills, of red and gray granite, 500 to 800 feet above streams, with little soil or timber. No grass except a narrow strip on little stream. Cacti and American aloe, piñon, and a little spruce on high hills. Land seems about worthless and sterile.

*Camp* 55.—At Camp 55 the valley has spread out to about two miles. The funnel-shaped mouth is formed by long, low, sharp spurs from the hills running out into San Luis Park. Some lines of low hills nearly cross the valley here.

These hills are granite, 300 to 500 feet high, barren of everything. The river valley in immediate vicinity of stream, and its arms, is green and fertile; elsewhere, except where artificially irrigated, it is covered with sage, (thorny kind,) and sand. Crops of fine spring-wheat are here raised; said to average fifty bushels per acre. Potatoes also are good. Up and down the stream are numerous ranches. They have comparatively little snow. Two blacksmith-shops, one store, and one saloon make the town. No timber on this part of the valley except a few small straggling cottonwoods. This fact, and the near neighborhood of Indians, would seem to make it an undesirable place.

*Camp* 56.—We passed out of Saguache Valley around the southern jaw of the valley into San Luis Park, and down this park about one to three miles from western foot-hills. Found the park here as below, and barren, except for sage-brush.

About seven miles from camp passed some brackish springs where is a cattle-ranch, the run being out in the park around the marsh, where the waters flowing in are supposed to sink. The road just here seems to be muddy, except in very dry times, otherwise it is admirable hard smooth gravel. About fifteen miles from 55 a brook crosses the road, and near 56, on Carnero Creek, is Royal's ranch; a stock ranch. Here is a poor stock run, narrow, but reaching far out into the park along the Carnero. The mountains along the north and east all day were peculiarly fine. The sky-line is wonderfully bold, appearing as deep serrated crests, and sharp peaks of every possible shape.

Along this range, from below the timber-line to near the crests, lay a bank of white clouds drifting slowly; effect, sharp sky-lines, soft white clouds, deep black gorge, sharp spurs, and sand-hills.

*From Camp* 56.—The foot-hills on right rugged, destitute of all vegetation, except piñons, and composed of basalt and lava, come out in spurs from main range. On our left was the broad, slightly undulating plain, covered with sage-brush and cacti, bounded by the Sangre de Cristo range; the Carnero and Garcia run out into the plain and sink in the marsh or hypothetical lake. We closed with our former line at Del Norte, and then marched to Camp Loma. We were detained a day at Camp Loma waiting for transportation, and obtained one wagon on the 19th; this was our entire transportation to Fort Garland, and this was filled to the bows, after our load was in, with pack-saddles. The consequence was that Mr. Hine lost thirty-eight negatives broken, a useless and irreparable loss, for which the officer furnishing the transportation was alone responsible.

*Return to Fort Garland.*—On July 21 we reached Fort Garland, thus closing our first line and completing the original schedule. Upon reaching Fort Garland I found orders to continue in the field, and make an examination of the various passes and approaches to the Ute country, from the Arkansas River as high up as the Twin Lakes or Red Mountain pass. Here an unfortunate delay occurred. The unskillfulness of soldiers in the handling of pack-mules had resulted in the almost entire uselessness of our train.

Application for a new train resulted in much correspondence and delay, and was only filled by breaking up some of the post teams. The time was partially utilized by sending a party to examine the Muscu Pass as to its suitability for a wagon-route, and Mr. Bassel's report of this is appended. We finally got off on August 23, under orders to proceed to the head of the northern waters of the Grand River, passing to the Arkansas at the most favorable point.

We retraced our old route as far as Camp 53, making this the initial point of our new instrumental line. No additional remarks are called for by the first part of this road, except that a cut-off was made from Fisch's ranch to the Carnero, over the waterless bleak desert, until the Garcia was crossed about two miles from the Carnero. From Camp 53 we passed to the north fork of the Saguache. We crossed the Saguache, following the old wagon-road of Gunnison's Pass up a small tributary, through a small cañon crossing to the north fork, and Camp No. 7 was made on a small tributary.

This portion of the route is in a shallow cañon. Here the cañon has become a shallow narrow valley, through hills of gentle slopes, their sky-lines, being about 500 feet above the creek. Some yellow pine is found, of no great size, and occasionally spruce and aspen. Bunch-grass is excellent up this valley on all visible hill-sides. No bottom, or bottom-grass, worth mentioning.

This region will afford admirable summer stock runs.

From Camp 7 we continued up the Little Creek Valley, which is well grassed, and pine and spruce increase in size and quantity. On either side are low rolling hills timbered and grassed. Two and a quarter miles above Camp 7 the road enters an aspen thicket, large and growing close, which continue for a distance of about a mile to the western slope. To this point the wagon-road is excellent, in fact continues so all the way to the agency.

There is for a short distance on either side of the summit a pretty steep grade, but not impassable even for heavy loads. On the west, as on the east, the approach to the pass is through a country of low rolling hills. Little timber but pine; grass and plenty of water.

*Camp* 8.—Camp 8 was on Pass Creek. Thence leaving the valley of Los Pinos and Pass Creek, the road ascends by a steep rocky hill about 200 feet on a rolling mesa country covered with sage, and cut by gulches running westerly into the Tumitchi. Here and there are little clumps of piñon and a few yellow pines, spruces and aspens in the gulches. On the right, distant a mile to 1½ are wooded hills 800 to 1,000 feet high, evidently the main divide. Along the stream is a little bottom with a dense growth of willows, brush, and few cottonwoods and good grass. All the gulches are well grassed in the narrow bottoms and carry very small, but clear cold streams. They afford little other wood than sage. The country continues much the same as on the preceding march, but takes the form of foot-hills rather than mesa. These hills are barren, with considerable out-cropping rock. The valleys or gulches are so wide, abrupt, and deep, that no practicable railroad-route is found and the grades are heavy even for a wagon road.

We entered the valley of the Cochetopa by a grassy gulch of about two miles. Here we found a fine bottom of one-half to one mile wide with luxuriant grass, a dense fringe of willows along the stream, and scattered clumps of well-grown cottonwood. Stream about fifty to seventy-five feet wide, and one to three feet deep, beautifully clear with pebble bottom. A pretty good pole-bridge across both Cochetopa and Quartz Creeks, built for the convenience of agency herdsmen. Camp 10 was in the bottom, about a quarter mile below; Quartz Creek here about 20 feet wide, and 1 to 3 feet deep, perfectly clear pebble bed. It has a bottom of one half mile for a distance of perhaps three miles before the mountains close.

*Cochetopa River.*—The Cochetopa bottom extends about ten miles above the junction of Quartz Creek, one-half to three-fourths of a mile wide and level; fine grass, little cottonwood, dense fringe of willows along same. The broken mesa country near the river is difficult to distinguished from the foot-hills. All north of the Cochetopa is a mass of these rugged foot-hills.

Our trail from Camps 10 to 11 was in the bottom of Cochetopa River.

At Camp 11 in Cochetopa Valley, the afternoon storm set in with the most violent burst of hail and rain I ever saw. This continued for an hour, flooding the camp, which had to be moved to high ground. During the evening and night were showers.

Many beautiful trout, weighing from ½ to 3 pounds, mostly about 2 pounds, were caught in the Cochetopa, and some teal and mallard ducks were shot.

Thence, about 9 miles to Camp 12, across the Taylor, on a narrow tongue between the Taylor and the Ohio Creek. Till within about 2 or 3 miles of the junction of Taylor River and Cochetopa Creek, the valley of Cochetopa is about 1 mile wide, well-grassed, with considerable cottonwood, altogether a beautiful valley; probably the winters are severe and frosts early and heavy. The lower valley of the Taylor is much the same in size and character, and at the confluence is a level triangle of fine bottom, containing 5 to 8 square miles. About opposite, where the trail comes into the valley of the Taylor, on the south of the Cochetopa, is seen the butt of the divide next west of Los Pinos Valley.

Here it has broken down to low hills but a trifle higher than the general level. Directly opposite on the north is a bluff-head running out into the valley, probably the ancient continuation of this divide and an old lake barrier. Where the river has cut though the divide is about 100 feet above the valley. Ascended hills west of camp, but could make no notes on account of wind. Saw Mount Chauvenet from the trail, and from these hills and bearings were obtained also high broken country between our old trail and the Grand River.

*Ascent of Ohio Creek.*—The ascent of Ohio Creek was one of the pleasant episodes of the march. Between the Ohio and the Taylor is a small bottom of triangular shape, 4 miles long and 3 or 4 wide at the base.

The Ohio bottom is about 1 mile wide with fine grass and a little cottonwood timber. For four or five miles the slopes of the foot-hills are covered with tall thick sage to a height of 50 to 100 feet above the creek. Elsewhere is fine bunch-grass with frequent small aspen thickets. After this portion of the valley is passed, the hills on either side are grassed thickly down to the bottom, and on the left they rise 500 to

1,000 feet above the valley, and have on top much fir and spruce. On the slopes are numerous "spring branches" with aspen thickets. On the whole this valley of the Ohio and of the Little Creek, on which is Camp 13, is a charmingly soft and enticing picture. The sunny slopes with waving grass, the little hill-streams and copses of aspen, the crown of dark evergreens and the background of the Cathedral rocks, forming a lovely whole.

These Cathedral rocks are, perhaps, 6 miles southwest from Camp 13, evidently on the spur running down west of the Ohio. They extend for one or two miles, are apparently of nearly horizontal strata of some soft rocks washed down, exposing cliffs and spurs 300 or 400 feet high. Many of these spurs are cut in sharp lines against the sk At one point a cliff like the end of a great cathedral, with strany efantastic spires and long rows of columns in tier above tier, showedg bold outline and forcibly claimed for itself the name it bears. The i nery continued the same to the head of the creek, where the ascen was steep and through dense fir, spruce, and aspens, then through glades and again through dense timber in the descent to Camp 14. The ascent of the Ohio Creek has brought us among the high peaks of a spur of the Elk Mountains. These peaks, high, ragged and formidable, with immense sharp crests and rising high above the timber, challenged a closer examination, and the party made a detour from its course for this purpose.

*Examination of the philosophers' monuments.*—A march of eight miles brought us over the divide separating the waters of the Taylor from the next tributary of the Grand to the West, the "Bah," an Indian name. The Bah is said to empty into Grand River, below the Lake Fork. Camp 15 was on Anthracite Creek, so called because of a vein of evidently fine anthracite coal found near its head by Thornton, the guide. Professor Hawn visited the ledge and secured specimens. The slopes of Anthracite Creek are densely covered with fine timber, and vegetation is luxuriant, and the grass in the glades as fine as bunch-grass could be. The head of Anthracite Creek is encircled by a rim of magnificently bold peaks, sweeping in a gigantic curve of many miles from the north and west, by the north to the south. These striking forms seemed to be worthy to bear the names of those philosophers whose writings have given an impression to the present century as permanent as their namesakes are in the heights of Colorado. Mount Richard Owen has two peaks, the northern of which is the higher, of dusty red rock, probably ferruginous quartz, or perhaps trachite. The peaks are of smoother slopes than those of syenite and trap, but are doubtless more difficult of ascent, as they present exceedingly sharp, unbroken slopes of small slide rock. From Mount Richard Owen down to Camp 15 is a crest of syenite. This crest, at junction with Mount Owen, has vertical faces of 200 to 300 feet, below which are slopes of *débris* of same height. This crest drops slowly down to the stream at Camp 15. Its crown is perhaps 5 to 20 feet wide, and too broken to travel on, with great rifts and immense spires. It seems like the ruin of a gigantic causeway, heading up to the peak beyond.

On the curve, beyond Owen and Spencer, are several smaller peaks. Herbert Spencer is a gigantic summit of several peaks, connected by sharp curved crests, with an inclosed basin slightly lower than the general height of the slopes and peaks. This mountain is of syenite or other light-gray rock, and presenting a grand confusion of pinnacles and buttresses cut by yawning gorges. It is a gigantic and wonderful mass, comparable to nothing but itself.

South of Spencer, across the creek, is Mount Huxley, a lone mount of light-gray syenite, sugar-loaf in general outlines, but presenting in all the slopes a remarkable array of conical spires nearly uniform in size and shape, arising from base to summit, covering the mountains, the deep shadows showing the bold relief of these spires. From Mount Huxley to Mount Stuart Mill is a low timbered ridge, and from Mill another low ridge extends to Carpenter, and then a line of ridges and crests extend to the summit south of Camp 14.

*Ascent of Mount Mill.*—From Camp 16, accompanied by Mr. L. Hawn, I ascended Mount Mill, starting at 10 a. m., and getting back at 5.30 p. m.

We found no difficulty in the ascent, but steady hard work for four hours and twenty minutes.

The timber, approaching the summit, extends from camp far up the slope, very dense, and fire-killed in places. The herbage is rank beneath, and fallen timber concealed under grass makes traveling tedious. We struck the foot of a back-bone extending one and a half to two miles from the peak toward Camp 16, up which we climbed. This back-bone is from 50 to 200 feet high, nearly vertical sides, and just sufficient crest to give foot-way. This gave us quite an easy ascent for a long way, but was broken at one point, where we had a descend to slide rock, and ascend again with considerable difficulty and risk. Found Mount Mill to consist of three or four peaks lying in the great curve already described as sweeping around from Mount Owen to south of Camp 14, connected by high crests, all above timber. The peak ascended is the highest of them. It is of syenite, light gray, very rugged, presenting, from a distance, little variety of form of surface, but nearer it is seen to be much broken.

West of the Bah River runs a gentle slope, said to be sandstone. Country heavily timbered to the divide of the Grand and the Gunnison.

This slope becomes much cut by gorges and cañons, but its surface indicates stratified rock. Northward, the view includes masses of immense peaks wild and formless, snow-capped, rising in chaos—nothing else. Southward and southeastward are peaks breaking away toward the Gunnison, and revealing the Uncompahgre Mountains in the distance. Heavy clouds prevented a view of the latter. Storms were seen in all directions—thunder, lightning, rain—and one high peak grand, black, and weird. Slight snow fell as we came down; rain below saturated us returning through the woods.

*Continuation of the march.*—From Camp 14, now become 17, the route was down a gulch called "Nigger Gulch," because it had been prospected by a negro.

There had been rumors of gold, but as the negro had not re-appeared, those rumors remained as such. The route lay high on the hill-side of the steep narrow gulch, through the richest of bunch-grass, two feet high, and bending under the weight of its seed like fields of ripe grain. Higher up the slopes is good timber—aspen, spruce, and fir.

Camp 18 was made at the junction of Nigger Gulch and Washington Gulch with Slate River. East River comes in a few miles further down. Slate River is a tributary of the Taylor.

*Lone Mountain.*—We remained at Camp 18 one day to allow of the ascent of Lone Mountain, an isolated peak between Washington and East River.

The outlines around the base of it are perfectly beautiful in the soft rolling outlines, green with luxuriant grass, and bright with clumps of aspens. Mr. Hine, Thornton, the guide, and I made the ascent, taking animals about one-half way up, and photographic material to within about

600 feet of the summit. The slope from Washington Gulch to the upper aspens, about one-half way up, is densely covered with the same beautiful bunch-grass before mentioned. Above this point is an occasional patch of aspen and spruce not of much size. Slide rock extends as low as the point where the animals were left.

Ascent beyond was not very difficult, but steep. From the summit the view was magnificent.

Down the valley we saw the junction of Slate and Taylor, and far beyond the valley of Los Pinos, the divide west of Los Pinos, Mount Chauvenet, and the end of the Uncompahgres. Northerly and northwesterly are the peaks of the Main Elk divide, high, rugged, and confused. These peaks present a great variety of form and color. Many of these expose strata of dark red brilliant rock, probably sandstone, alternating with thin, gray strata, the exposed face being hundreds of feet, and the strata dipping at angles of all degrees between 0° and 60°.

Other peaks expose dark strata, probably slate or shale, while the highest are like Lone Mountain, covered with dark-gray syenite. Eastward are the lofty peaks of the main range. Close under the eastern base of Lone Mountain flows the east fork of Slate River, a stream thirty feet wide and one to three feet deep, with a considerable velocity and very clear. On the west, between Lone Mountain and Camp 18, is the mouth of Washington Gulch, which is nearly parallel to the Slate for five or six miles above.

The valley of the Slate is here about two miles wide, and of the East River probably one mile, and below the junction the valley may be two and a half or three miles for a short distance. The hills seem, however, to close in rapidly. Down near and below the junction there is in places considerable sage, but not so much anywhere as to crowd out the bunch-grass.

There is much slate in the bed of Slate River, but mostly in form of gravel and wash. The bed of East River is made of bowlders of sandstone. The creek in Washington Gulch has a solid smooth bed of dark slate. Washington Gulch diggings, (placer,) never rich, seem abandoned now.

There are are rumors of diggings on Rock Creek, a branch of the Grand, (or Roaring Fork,) which heads against East River.

A wagon-road goes up East River, coming in by Cochetopa Pass and the Taylor; wherever we saw it, it was an excellent road.

*Slate River.*—From Camp 18 our route was down the valley of the Slate River, the trail for the first two miles being close to the steep slope on the right of the valley to avoid the numerous soft places in the flat. Thence we turned across the valley to the left slope near the south end of Lone Mountain, (the valley at this point being about three-fourths of a mile wide,) crossing at the same time a good wagon-road which leads up from Taylor River as far as the entrance of Washington Gulch.

Below Lone Mountain the valley widened to about one and a fourth mile, gradually contracting to about three-fourths at the junction of East and Slate Rivers, about six miles straight below Camp 18; thence in a mile it gradually widens to about a mile at the mouth of Cañon Creek, in the valley of which we made Camp 19.

*Cañon Creek.*—Cañon Gulch contains good bunch-grass, but herbage is much less luxuriant than on the other waters of the Slate. Cañon Creek is about 10 feet wide and 1 deep, rapid, with sandstone bowlder bottom. For two miles up the creek there is no bottom land, the hills rising from 800 to 1,000 feet, and timbered to the water's edge with aspen, fir, and spruce. Here and there are exposed red and gray masses of sandstone. The trail then leaves the gulch, rising to the hill-top on the left to avoid a cañon through which the creek passes. This cañon is a half-mile long. The north side is a nearly vertical wall 300 to 400 feet high, of red and gray sandstone, and the other side a timbered slope. After passing the cañon the trail descends again to the stream. Here is a valley two miles long by three-fourths wide through which the stream falls with little flow. Here are numerous springs flowing down from the hills, and the usual fine bunch-grass. The hills are 500 to 1,000 feet high and expose ledges of dark red sandstone. From the head of this valley the trail leaves the creek and turns sharply to the right, up a very steep, heavily-timbered hill, about 1,200 feet above Cañon Creek, while the creek comes down through a gulch with steep, high mountains of red sandstone.

*Deadman's Gulch.*—From this divide the descent led us to Deadman's Gulch, which is a steep, narrow gulch with an ice-cold and perpetual brook of little size. Its slopes where exposed are grassed knee-deep with bunch-grass.

The hills on either side are, perhaps, 1,000 feet high, steep and heavily-timbered with spruce and fir; much of this timber is fire-killed.

This region between the Slate and Taylor is very high, with rounded sandstone hills, much cut by gulches, like Deadman's.

*Spring Creek to Taylor River.*—The divide between Deadman's Gulch and Spring Creek is a hilly, grassy ridge. Spring Creek has a bowlder bed, is about 20 feet wide, and 1 to 1½ deep. The valley below narrows to a mere gulch between barren hill-sides. Above, the valley is wider and the creek appears to head, together with Deadman's, in the Elk Mountains. Our route carried us up a tributary of Spring Creek, a country of sparse timber and grass and much sandstone *débris*, over a low, flat divide, and down a small tributary of the Taylor River, on which we made Camp 21, at the edge of a flat, swampy glade, about one and a half mile long, northeast and southwest, by half a mile wide, in which was plenty of very poor grass.

The camp was in heavy timber, on the skirt of a steep hill, and was a very poor one for stock. The glade was surrounded by dense spruce-pine timber and ended in a rocky cañon at the northeast end, down which our trail led to Taylor's River. The bed of the stream in this cañon was filled by enormous bowlders, and the sides were covered by the charred remains of a burned forest. At a sudden turn in the trail we found ourselves on the side of a hill, overlooking the valley of Taylor River, into which we descended, making Camp 22 on the main stream, about one mile above the mouth of the creek, from out of Red Mount Pass. We staid a day or two in this camp, while I made arrangements for my scout to go to the head of Taylor River, and to give Professor Hawn an opportunity to visit a mining settlement on a spur of the main range, about two miles above the cañon, and for Mr. Hine to visit and photograph the cañon.

*Prout's scouts.*—At Camp 22 I turned the party over to Mr. Bassel, with instructions to continue the line, awaiting my return at mouth of South Arkansas, unless I joined them sooner. With Thornton I started up the Taylor, endeavoring to reach Tennessee Pass by some of the waters of the Grand, being encouraged by the fact that an old trail leads up the Taylor, and the Taylor slope of the pass looks practicable. We marched rapidly up Taylor, and for a mile or so up West Fork upon a plain, and open old trail, which turned to the right, up a tributary of West Fork. The gulch of this tributary lies in timbered hills, at the base of a spur of Elk Mountains. At the head of the divide, a long grassy ridge, with elevated knobs. From the summit we could see a stream flowing northwest, and heading one mile to our right, directly opposite the Middle Fork. A well-marked trail could be seen going down this stream till it entered timber. While making the necessary detour along the summit we found a little snow, and on it were seen three white mountain grouse, very shy. We shot one. It was a perfect beauty; somewhat larger than a domestic dove, small head, short strong beak, plumage dusk gold and gray, mottled on head, neck, back, and base of wings, elsewhere pure white, tail rather long, feathers to toes, eyes pink, runs very swiftly, meat very dark but of exquisite flavor. From this summit we could see that we were at the base of Elk Mountain, and that this ridge is the connection between Elk and main range. To the left it splits, one spur sweeping down parallel with Taylor till cut by the cañon thereof, and joining main range near the head of Quartz Creek, the other spur continuing along toward the head of Slate, as main Elk divide. This portion is extremely rugged. Many of the highest peaks seem stratified, cut down into forms of incredible wildness and boldness. We descended on to the stream mentioned, and quickly entered dense spruce-timber, well grown. The descent is rapid. Trail bears unmistakable marks of having been used by men, but not recently. Found considerable fallen timber in places. Stream runs in a steep, narrow gorge, with no bottom-land, and dense timber to water's edge. We traveled as fast as possible, making about 24 miles, and established Camp 1 at 7 p. m., then dark, in a small opening where the timber had been swept away by a snow-slide.

About two miles below Camp 1 is the junction in a small valley of our stream, and one coming down farther west, which we call Big Fork.

Our Brook is about five feet wide, clear and swift, with bowlder-bed. Big Fork is ten to fifteen feet wide, a clear, swift, fine volume of water, bowlder-bed. The rock exposed so far is syenite, quartzite, and coarse feldspathic granite. Sandstone bowlders are now found in the streams. Up to this point the trail has been bad in the narrow steep valley, densely timbered from crest of the mountains, 1,500 feet high, to the water's edge. Passing down the small valley we found it remarkably pretty. The mountain-slopes are covered with bunch-grass in all the glades and gulches. Here and there timber meets at the water, but there is mostly a belt of one-fourth to one-half mile of grassy slope. Wherever there is any level bottom it is flooded by beaver-dams. Signs of elk and deer abound. Still no signs of recent travel on the trail. All cutting at least three to four years old, and little of it. No sign of fire anywhere within a less time than three years. The hills on the west begin to show strata probably of sandstone, but much cut down, taking irregular and picturesque forms. Opposite Moon Camp the mountain-side reveals a wonderfully pretty picture. The aspens grow high up, turned in patches yellow and red, pale here, vivid there, pale green of unfrosted foliage, and deep green of spruces scattered in clumps everywhere. Through this the red, brown, jagged cliffs come out here and there, and one solitary rude peak stands high and sharp over all.

As far as the valley of the junction with Roaring Fork the scenery and general character of the route remain much the same during the descent of Our Creek. We passed one tributary coming in from the southwest, and were compelled to avoid a cañon of 300 to 400 feet in depth, through which Our Creek passed. This cañon was formed of dark red sandstone. We then, before long, enter a valley where four forks unite with each other. That coming down west of Ours is about its size, *i. e.*, 25 to 30 feet wide, of slight depth, swift and clear, bowlder bed. The head of the valley is here; below, it continues about eight miles, where the Sandstone Mountains close in, and there seems to be a cañon, seen from above, 500 feet or more deep; not a box. The valley is level. Much sage; little grass; sage uncommonly large. To the left, as we descend, are sharp, barren foot-hills of the Elk, much cut by water-ways. These hills, as seen, rise from 200 to 400 feet above the valley. On the right are mountains 2,000 feet high. I judge this to be the Roaring Fork, and the mountains are the spur from the main range between Roaring Fork and Eagle. On the right, for miles, are seen two perfect water-benches, sharply cut and broad on top.

The lower is perhaps 50 to 75 feet above the top of present cañon, the upper about one half that distance above the first. Did not observe those on left, but saw distinct bench somewhat lower. Had occasional glimpses of Elk Mountains and peaks of main range.

I now determined to descend no farther, but to strike eastwardly for the main range and the pass.

We retraced our route and crossed the Roaring Fork about one mile above camp; found plain trail up north bank, turning to the left up a deep, narrow gulch. Gulch narrow, sides very steep, in sandstone hills, 1,000 feet high, heavily timbered. Four miles from camp, trail turns to the right and climbs steadily for 1,500 or 2,000 feet up the face of a sandstone hill, with much broken rock and sparse vegetation. On top we found a broad plateau with timbered ridges crossing it, dividing various heads of tributaries of Roaring Fork. Passed about four miles across this plateau over bunch-grass of finest quality and great quantity, through a spruce forest with much fallen timber, and crossed a tributary of the Roaring Fork, probably that which empties four or five miles below Camp 3. Then traveling northwardly about three miles we came to the crest of a ridge, from which the ground fell fast to a large stream, perhaps the Eagle, thought by Thornton to be a branch of the Roaring Fork.

The descent to this stream was very steep and perhaps five miles long, and covered with a dense mass of fallen timber. With before us the certainty of a very difficult march to this stream, and with the possibility after reaching it of being compelled to go down and make a long detour, or to cross the ragged mountains to the north of it, and with the necessity of quickly reaching the party, I concluded to abandon the scout here and retrace its seventy miles.

The trail was very dim, and had often disappeared. On our return we lost it. We found ourselves in a dense spruce wood, and were kept to the left of our route by much fallen timber. Just at dark we struck the head of the gulch, by which we left the river in the morning. Followed down the western side of this gulch till long after dark, but found no water nor place level enough to picket our animals. The hill-side was extremely steep, with broken angular masses of sandstone, fallen timber, scrub-oaks and other brush, and the night as dark as a cloudy, moonless night could be. We led the animals along this slope from fifty to one hundred and fifty feet above the bottom of the gulch; one pack-mule once slipped and rolled to the bottom, but we got him up again. Finally found a little bench affording standing room for animals, and camped without water or grass. Our return was over the same route, and the monotony was varied by a day's ride through a soaking rain, and the crossing of the divide back to the Taylor in the midst of blustering snow-squalls. We descended the Middle Fork of the Taylor, and found it no better than the route by which we ascended. Within three or four miles of Camp 22 we turned to the left across foot of the spur into the gulch of Red Mountain Pass.

*Red Mountain Pass.*—Approaching the pass from our Camp 22, the ascent for a distance of about four miles is not very steep and the trail is good. One mile from camp the trail crosses "Pass" Creek, and thence continues up the left bank of the stream for about three miles, where it again crosses to the right bank, entering very dense pine timber. Thence for a distance of half a mile the ascent is easy, and then the trail rises suddenly on the hill side, and is very steep, rising fully seven hundred feet in half a mile or less. There is no dangerous place, and it is in timber for the greater part of the ascent. After leaving the timber the ascent is still steep, but less so, and the trail becomes gradually more and more level until the summit is reached, where there are two or three small ponds.

From the brow of the hill above timber a grand view of Taylor Valley is obtainable, but nothing can be seen westwardly from the summit of the pass, which is a steep walled cañon, having its axis N. W. and S. E., the trend of the valley below being S. S. W.

From the point of view indicated is seen Taylor River and mountains west. The pass is one of the highest and ruggedest yet seen on the expedition. On either hand rise great snowy peaks, cut by gulches, bare of vegetation, and having the sharp-curved crests shown in most of these high ranges.

On September 20 there was about an inch of snow on the pass, the first this season. The summit of the divide is parallel to the general course of the valley of the Lake Fork, and is part of the right wall of that valley. Standing on this summit, and looking in the direction of the trail from Taylor, the line of sight is square across the valley of Lake Fork, and the descent is down the steep side of the mountain, a fall of over eight hundred feet being made in less than twenty-five hundred feet, to accomplish which the trail is zigzagged, and is in places very boggy, and difficult for pack-animals, a great deal of water coming out at the foot of the mountain. The first view of the valley of the Lake Fork is dreary, but little timber, poor grass, and dense scrub willows in the bottom.

Near our Camp 23, which was distant about three and a half miles from the summit, there was a little grass, sufficient for our stock for two days, and this, with a small glade eight miles farther down, were the only good camping-places between the summit and the lakes. Here and there in the bottom, at the confluence of torrents, were some patches of fair-sized spruce-pine, but most of the timber was small.

About 400 feet up the mountain-side, on the right bank, is a very well marked water-line, denoting level of former lake, of which present lakes are the remains. The valley of the Lake Fork is generally rugged and narrow, more especially for the distance of three or four miles above the lakes, where the stream runs in a bed of huge bowlders, and in one place under a picturesque natural bridge of rock. Camp 24 was on the shore of Upper Lake.

*Twin Lakes.*—The Twin Lakes are two beautiful sheets of water, about four miles in joint length from east to west, and a mile and a quarter in greatest width, the upper lake being the smaller.

About half a mile above the lakes the valley of the Lake Fork opens out, leaving a flat, stony, willow-covered bottom, which, a little farther down, (near the lake,) changes to grassy swamp. The mountains on the right bank maintain their line to the eastern end of the lower lake, and then fall away southwardly, forming the right side of the

Arkansas Valley. The mountains on the left bank turn abruptly northward near the west end of the upper lake, and fall toward the Arkansas in a series of low, rolling ranges, the whole forming a triangular valley with sides apparently seven or eight miles long.

The lakes are beautifully clear, and abound with very large trout. I was informed by a settler living in a large, handsome house, on the bank of the lower lake, that ice forms 3 feet thick in winter. Our Camp 25 was on the river, between lower lake and Arkansas. About a mile and a quarter below the lower lake the Lake Fork joins the Arkansas, which runs southwardly in a valley about 7,000 feet wide, the river running close to the eastern side.

*Arkansas River.*—The valley gradually contracts, until it is nothing but a narrow gorge below Granite City. About two miles below the junction of Lake Fork our trail entered the cañon of Cacti Creek, in which were placer-mines, and this was followed for about a mile to Granite City. The mountains on the east or left bank were rugged and of syenitic formation. On the right the mountains of the main range, the foot-hills of which compose the valley of the Upper Arkansas. They break down into rounded, low hills and plains, covered with a loose, gravelly soil, many bowlders underneath, as is shown where the soil is cut through by the action of water. Gold is found in all of these mesas, but not in paying quantities. Some washing has been done, but the "diggings" are nearly deserted. On Cacti Creek is an extensive placer-mine, now abandoned, and a village nearly deserted.

*Granite City.*—Granite City is a mining-town at the junction of Cacti Creek and the Arkansas, and is the county-seat of Lake County. It does not appear to be very prosperous. From this town a very excellent wagon-road has been built down the valley to Cañon City, in many places cut out of the solid rock, and in others built of bowlders under the cliff in the torrents of the river. It is a creditable monument to the enterprise of the citizens of the vicinity.

From the upper end of the Twin Lakes to Cañon City the road is good and practicable for wagons without exception.

Below Granite City the valley for a distance of about five miles is very narrow, generally a mere cañon, with scarcely room for river and road. Below this the valley opens gradually, and at our Camp 26, about six and a half miles below Granite City, the valley was about 2,000 feet wide, the river running close to its eastern side. I overtook the party at this point. From Camp 26 to 27 was a distance of nine miles, the valley becoming wider as we descended, until at Camp 27 it was about two miles wide, nearly level, cut by shallow gullies. Soil thin and gravelly. Little grass; that poor, and sparse growth of piñon. Fair crops of oats, barley, and potatoes are raised on the small portion which is cultivated. On the east of the valley is the spur dividing Arkansas waters from the head-waters of the South Platte, a low range, 800 to 1,200 feet, sparsely timbered, with rugged slopes of bare, broken syenitic rock.

*Cotton-wood Creek.*—Camp 27 was on Cotton-wood Creek, in a thicket of cotton-woods perhaps a mile wide, extending across half of the valley. These cotton-woods were 30 to 50 feet high, but twisted and of no value as timber. Good grass and fair water. Cotton-wood Creek is a clear, cold mountain stream about twelve feet wide, one foot deep, and swift, with bowlder bed. For six miles below Camp 27 the valley is about two miles wide, and has the same general characteristics. The river runs under the eastern mountains for about two miles, and then runs in the middle of the valley. At the point where the river recedes from the eastern mountains the road crosses to the left bank by a good truss-bridge. Sloping down directly from the mountain's foot is a mesa of variable width to three-fourths of a mile. This breaks down with a pretty steep slope of about twenty feet vertical descent. Another mesa breaks down with another bench to the present river-bottom. These mesas mark remarkably well the old lake-levels. They are nearly barren, with many large bowlders, and very little grass or other vegetation. Where Chalk Creek runs down, there are on either side ridges running down to the river, making a basin of considerable width, and also at Brown's Creek. From the sixth mile below Camp 27 the valley gradually widens, until it is fully three miles across. Fourteen miles below Camp 27 the hills close in, and the river runs in a low cañon. These hills are rocky and covered with small piñon. Just above Camp 28 the river flows through a cañon having one wall of about 200 feet; often lower.

*Chalk Creek.*—River here 100 feet or 150 feet wide, swift, with bed of large, smooth bowlders, and depth of three feet. Immense growth of cactus, and but little else. Chalk Creek is twenty-five or thirty feet wide, a brisk volume of water, with a grist and saw mill, and thrifty-looking house. The creek comes out of main range by a gorge or cañon, and there seems to be a very low pass by it, but probably it is a difficult one, as it is not used. On Brown's Creek are several ranches, on which the farmers were cutting wheat September 24. The straw is small and looks very green. Our Camp 28 was on the river near forking of the road down the Arkansas and that leading over the Puncho Pass.

*September* 25.—Mr. Bassel and Lieutenant DeLancy here left us with an escort and a party consisting of Mr. Bassel, Mr. Austey, and Mr. L. Hawn, with instructions to run the line at least as far as Kerbu Creek, in Homan's Park, and, if practicable, to the Musca Pass line, then proceed to Fort Garland and discharge the party. From Camp 28 our line was run down the left bank of river along a mesa, sloping slowly to the river front of foot-hills of the spur running down northeast of Arkansas. The valley on the other side is closed by broken and timbered face of mesa between Arkansas and South Arkansas. The valley is here triangular, with sides about 5 or 6 miles long, and the openings of Puncho Creek and the river above and below in the angles. Bottom looks pretty fertile, where irrigated, but that portion crossed by us is a barren plain of sand and cacti. Considerable stock were running in the valley, but they require a large range. There are several ranches in the valley.

On the south is seen, just west of Puncho Pass, the base of the Sangre de Cristo spur, marked by several high peaks, rugged and timberless for 1,000 feet. Just above junction of the South Fork the wagon-road crosses to the left bank, and a mile below enters a cañon, at the upper end of which was our Camp 29. The southwest wall of this cañon is formed by the foot-hills of the Sangre de Cristo range, and the northeast wall by the foot-hills of the range between the Arkansas and South Platte. The summit of the Sangre de Cristo range was seen at times through a gulch, being about five or six miles distant. The summit of the spur between the Arkansas and South Platte was not recognized; perhaps, however, it was the line of hill tops seen from the trail. This cañon exposes, first, trap or basalt, then a stratum of compact gray limestone, afterward an immense stratum of dark-red, coarse sandstone, with here and there a thin layer of lime. The cañon is close, but not a "box" cañon. Hills seldom open out, and never to give any bottom.

The slopes are extremely rugged, with small, sparse piñon and a little scrub-oak. After the first 3 miles gramma grass is found in sufficient quantities for a few animals. Occasional brooks come in. River 100 to 150 feet wide, swift, deep, and turbid, often flowing through narrow throats or "dalles" of sandstone. At 1½ miles out found a thrifty looking cabin, put up by a man named Rich, who has found and located a vein of copper-bearing quartz, said to be rich, and he is preparing to work it. A mile below camp, the river cuts through sandstone in a sharp S-curve, running in a deep, close gorge. Great strata of red and gray sandstone, dipping at all angles, and cut down in gulches, make a very picturesque place, the cañon being here 300 or 400 feet deep.

*Badger Creek.*—Camp 30 was made on the left bank, at mouth of a small, brisk creek. Badger Creek coming in from hills on the north, having a small park, fair grass, and plenty of wood and water at its mouth.

Much work has made an excellent wagon-road through this rough country. A quarter of a mile below Camp 30, the hills close in again for about a mile, and then open out into a valley about half a mile wide at the upper end and eleven to twelve miles long, apparently an old lake-bed. As the river winds through the valley, it leaves one side or the other a gravelly mesa, sloping from foot-hills to the river bottom. The river face of this mesa is about 25 to 50 feet high, sloping sharp to the river bottom. This bottom is about 500 feet wide and fertile looking. Several ranches, with fields of grain, wheat cut, and oats standing, one small field of cut corn was seen, which looked worthless. This is known as Pleasant Valley, and ends at the cañon of the Arkansas, where it is about a mile wide. We made Camp 31 at the south end of Pleasant Valley, on a small creek flowing from the southwest "Spring Creek." The river turns to the northward into a granite ridge, perhaps 700 feet high, and about a quarter of a mile below Spring Creek enters by a small cañon, and a quarter of a mile farther a dry gulch comes in from the right. Here the walls of the main cañon are about 200 feet vertical height, of compact red granite strangely striated with waving lines of basalt. These walls are vertical in few faces, but broken down in steep, irregular, jagged slopes. Total depth, 500 to 700 feet at entrance, but it evidently drops off fast into lower hills. A picturesque place, but not large enough to be impressive. My inspection was hurried after a day's work on the line. Spring Creek, at Camp 31, is about 10 feet wide, swift and clear; in its gulch is fair grass, and a thick growth of scrub-oak, cotton-wood, and choke-cherries, with much rhus toxicodendrum, or wild clematis. Immediately beyond, the road rises into the ridge of granite hills forming the lower barrier of the lake, now Pleasant Valley, cut through by cañon. These extend from the ridge, all day along the northeast of the river around into the foot-hills of the Sangre de Cristo range. They are masses of water and weather-worn granite, red and coarse looking, like piles of great bowlders, and have a soil supporting sparse growth of piñon, &c. The wagon-road is excellent from the good bed naturally, and from a great amount of work having been done on it. Marched about ten miles by the line, but probably twelve by the road, as it winds among the rugged hills in a most devious course. For five miles we passed over hills extending from the range to the cañon of the Arkansas, and evidently continuing of the same character back to the divide northeast of the Arkansas, that is, loose, rugged hills of broken granite and basalt, nearly barren, except for a little piñon, gramma, and scrub-oak; cut by deep, steep gulches, running down toward the river, formidable to traverse, and worthless. A little stock runs in these hills, and an occasional cabin is found in the gulches. Beyond a brook known as Oak-Grove Creek, distant about four miles from Camp 31, we rose to a mesa sloping from the mountain to the junction of Texas Creek and the Arkansas. This mesa was cut by shallow gulches, and afforded grass for some stock, little, however, back toward the mountain. This mesa was beautiful with yellow and scarlet autumn foliage on sunny slopes, but these slopes are, doubtless, rugged and barren.

From this mesa we turned left, leaving the upper end of Wet Mountain Valley on our right, one or two miles away, and descended to the gulch of Texas Creek. The mouth of Wet Mountain Valley is one or two miles wide across from hills east of Texas Creek to Sangre de Cristo Mountains. Texas is a creek of 30 to 50 feet wide, clear and swift. There is a large saw-mill where the road strikes it, and a ranche (Lamb's) half a mile below, at which place we made Camp 32, in poor grass.

From Camp 32 our course lay up a dry gulch winding up through the rough hills, which seem to lie between Wet Mountain Valley and the river, passing out, in about three miles on, to a flat mesa country with gravely surface and cut by deep gulches. Kept this for six miles, when we entered Webster Cañon, a steep, narrow gulch of granite and trap, very rough and having a dry stream-bed. In the cañon were seen wild hops, clematis, choke-cherries, currants, some scrub-oak and long-leaved pine. About a mile and three-quarters above Camp 33 the cañon is contracted, forming Jenkins's Gate, a cleft through a spur of rock which once closed the valley. Here the opening is about 150 feet wide at top and 50 feet high; walls vertical.

From Jenkins's Gate to Camp 33 the cañon is nearly a box one. Camp 33 was made at a point where the walls of the cañon fell back and opened out as steep rounded ranges, in which a little poor grass was found for our stock.

From this camp our road was up a branch of the cañon, which, in about four miles, brought us out on a high waterless broken mesa, sloping from the Greenhorn range toward the Arkansas. In the cañon, by which we rose to this mesa, we saw the round-leafed cotton-wood of the Missouri Valley, tall cacti, and oaks about 25 to 30 feet high. The road was over the mesa country in a nearly due north course for about four miles, when we reached the Arkansas at a point where its cañon breaks down the road, here crossing to the left bank by an excellent truss bridge, near which we made Camp 34. Near to this camp, on the slope in a bend on the right bank, was a well-improved farm, at which we were able to purchase much needed fodder for our stock.

In the hills near the bridge and in the cañon below strata of very white sandstone are exposed.

We crossed the river at Camp 34, and passed up a steep narrow gulch out on to a mesa extending from the spur, at the extremity of which is Pike's Peak, to the cañon of the Arkansas. About five miles above Cañon City, the road enters a shallow, wide, flat-bottomed gulch, close to a range forming the north boundary of the mesa, in which is a stream. The sides of this gulch expose deep ledges of limestone, one to two hundred feet thick, having an easterly dip of about 10°. At a point about four miles above Cañon City, the sides come close together, forming a box cañon about 50 feet deep and 400 or 500 feet long. We followed this gulch down to the Arkansas at its exit from the cañon about a mile above Cañon City, making Camp 35 on the bank of the river. From Cañon City there is a macadamized road, and graded road-bed for railroad, down the valley to Lebran, where the Denver and Rio Grande

Railroad is struck. The existence of these and the land surveys makes it unnecessary to describe the country further. The party reached Pueblo on October 3, and on the 4th was broken up.

The report of Assistant James Bassel on the Musca Pass and Puncha Pass are appended.

H. G. PROUT,
*Assistant in Charge.*

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## SUB-REPORT ON MUSCA PASS AND PUNCHA PASS LINES.

FORT GARLAND, COL.,
*August* 20, 1873.

SIR: In compliance with your instructions of the 12th instant, I have the honor to submit the following journal as a report of my operations, from the time of our leaving this post on that day until our return on the 19th instant:

*August* 12.—Left Fort Garland at 9 a. m., with the line passing around the base of Sierra Blanca Mountains on the road to Musca Pass. For the first mile or two the road passed over a dry, flat, gravelly desert, covered with a growth of prickly pear and stunted sage-brush. Thence over a more elevated and slightly undulating country of the same character as to vegetation, but more sandy, and cut up at intervals by arroyas running down from the foot-hills into the desert—the foot-hills of Sierra Blanca, half a mile to the right of the road, covered with a thick growth of cedars and piñon pine. Made first camp seven miles from Fort Garland at one o'clock p. m., near some springs, just north of a dry bed of a stream, the course of the latter being indicated by a belt of cotton-woods from a point a little to the west of the road back into the foot-hills of Sierra Blanca. There was a depression or valley on each side of the dry bed of stream a mile in width, and on the north side was a slight rise in the country for half a mile, and then a depression in which the springs were situated; wood and water enough, but of inferior quality, while grass was abundant and of fair quality over a bottom a mile in width, extending from the foot-hills out into the desert of San Luis.

*August* 13*th*.—Broke camp at 6.30 a. m.; country of much the same character as the day previous, except that, being near the foot of mountains, there were more rocks scattered over the country, while in places there was heavy sand, with a more vigorous growth of sage-brush, and the road crossing frequent arroyas; made nine miles and a half, and found stream running down from the mountain into the desert. Water is not found here usually as far from the mountain as the road, and at this time it sinks about a mile to the west of the wagon-road.

Camped at 11.30 a. m.; on this stream grass very scarce; plenty of wood and water; saw six antelopes during the day and one mountain sheep near the camp; game must be abundant, judging from the signs found on the sides of the mountain. During the day's march could see the belt of timber marking the course of the Rio Grande River more than twenty-five miles to the west of our route, the view over the San Luis Valley and of the mountains surrounding it being very grand indeed; unable to get azimuth to-night on account of clouds; storm, accompanied with lightning and thunder, on the Saguache Mountains and on the mountains west of the valley; no rain at our camp.

*August* 14.—Broke camp at 7 a. m.; marching over a country closely resembling that passed over yesterday; down in the edge of the valley, a mile or two to the left of our route, there appeared to be springs breaking out in many places, much improving the desert appearance of the country over which we were traveling.

Our road appeared to lead across an inclined plane running down from the foot of the mountain to the edge of this grassy plane, which is probably very boggy in places on account of the water which must run down into it, and for which there is no visible outlet on the surface of the ground. Four miles from camp crossed a stream called the Zapato Creek, which is lined with timber from the mountains out into the plain, a mile to the west of the road, where the water finally sinks in this spongy reservoir. A mile north of this creek the road became very sandy, and continued so for six or seven miles, when our course turned a little more to the east, bringing us nearer the mountains on a higher and less sandy country.

Off to the north and west of us was a very peculiar line of sand-hills, two or three hundred feet high and from ten to fifteen miles long, and from six to eight miles in width. Their appearance would indicate the combined action of wind and water in forming them. At 2 o'clock p. m. arrived at the Musca Creek, which flows out from the Musca Pass, running down to the foot of these sand-hills, where it unites with another small stream coming out of the Sand-Hill Pass five or six miles north of the Musca Pass, and running around the eastern end of these sand-hills.

Both sink in the sand at the foot of these sand-hills. Camped at the mouth of the Musca Pass, having made eleven miles; wood and water abundant, but grass very scarce. In company with the guide rode through the pass this evening, and concluded that it would be possible to get our wagons through by repairing the road in places; very cloudy this evening, which continued throughout the night.

*August* 15.—Weather very cloudy and threatening. Broke camp at 7 o'clock a. m. and started through the pass. After hard labor on the part of all hands and the mules, we made about a mile, when the wagon upset. It being then about 2 o'clock p. m., and beginning to rain, pitched camp in the cañon near the scene of our misfortune. Heavy showers fell soon after going into camp, which continued at intervals during the afternoon and night, preventing our obtaining azimuths. Had to send the mules up to the summit of the pass for grass, where there was abundance of it, about two miles from our camp; plenty of wood and water where we camped.

*August* 16.—Morning broke tolerably fair, only a few clouds being visible; determined not to attempt moving camp, but have the line run through the pass on to the head of the Huerfano. The line was run seven miles over on to the head-waters of the Huerfano and tributaries of the Muddy Creek, and stopped at the head of a cañon leading down to the valley of Muddy Creek, which empties into the Huerfano from the northwest about two miles above Badito, at Mr. Moore's ranch. Turkey Creek rises in the Greenhorn Mountain and empties into the Huerfano, on the same side, and five miles below the mouth of Muddy Creek. Muddy Creek rises near the divide between the Huerfano Park and Wet Mountain Valley. The Huerfano itself rises among the high peaks of the Sierra Blanco, north side. The country from the Musca Pass down into the valley of the Huerfano is very singular and very beautiful. It is a series of narrow, grassy slopes, with ravines containing small streams between them, extending from the mountain four or five miles, and then breaking down more or less abruptly a height of 300 or 400 feet on to the plateau covered with cedar and piñon pine and wide, open, grassy glades between these thickets of timber, the whole sloping gradually down to the valleys of the streams. This seems to be a fertile and well-watered valley, with plenty of timber, and a very abundant fall of rain, for it was raining in the valley almost every afternoon.

Pass Creek is a stream emptying into the Huerfano from the south, about six miles above the mouth of Muddy Creek, and rises just west of the Sangre de Cristo Pass. At the head of this creek is a pass more than five hundred feet lower than the Sangre de Cristo, and far better suited for a wagon-road to Fort Garland than the latter, over which the road now passes, and probably much superior to the Veta Pass for a road practicable at all seasons of the year. A good wagon-road could be built over the head of Pass Creek with very little expense. But in view of the probability of the establishing of a military post on the Upper Rio Grande, and probably another in the Cochetopa Pass also, the Musca Pass is the one through which a road should be constructed for the supply of these posts. The Ute Indians always go through this pass in going east or west. I caused a careful barometric section of this pass to be made, which showed that it was about 300 feet lower than the Sangre de Cristo, with approaches very much better than the latter-named pass. A good wagon-road could be constructed through this pass at small cost, and would be thirty-five miles shorter in going from Badito to Loma or Del Norte, than by the present traveled road, via Sangre de Cristo and Fort Garland, and a saving of sixty miles to the Cochetopa over the present route just mentioned.

Received orders this evening to return to Fort Garland at once, which prevented the continuation of our line into the valley of the Huerfano, as contemplated. Weather still cloudy.

*Sunday, August* 17.—Had the wagon taken to pieces and set up preparatory to moving out of the pass the way we had entered; packed our necessary baggage for camping over-night down to the mouth of the pass, and got the wagon, with the remainder of the baggage, down in the morning.

The clouds fortunately cleared away this evening, and we obtained azimuth for the first time since leaving Fort Garland.

*August* 18.—Got the wagon out of the pass this morning without further trouble and broke camp at 8.45 a. m., making twenty miles by 3 o'clock p. m., and camping where we made our first camp on our outward march.

*August* 19.—Went into Fort Garland this morning, arriving at 9 o'clock a. m.; reported and went into camp on Ute Creek, half a mile from the post.

The usual meteorological observations were made, and all possible time and facilities given to the photographer for executing his work.

All of which is respectfully submitted.

JAMES BASSEL,
*Second Assistant Ute Reconnaissance.*

H. G. PROUT,
*Civil Assistant in charge Ute Reconnaissance.*

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FORT GARLAND, COLORADO TERRITORY,
*October* 2, 1873.

SIR: In compliance with your instructions of the 24th September, 1873, I have the honor to submit the following journal as a report of my operations from the time of the separation of the party at Camp No. 21, on the Arkansas River, up to my arrival at Fort Garland, on the 1st of October.

*September* 25.—Left camp this morning at 6.30 a. m., and ran the line down the south side of the Arkansas River for three miles; then turned off to the south, leaving the river and crossing a ridge or mesa covered with piñon pine and cedar; thence down to the South Arkansas and across that stream at the mouth of the Puncha Creek; then up that creek, about two miles, when the wind, which had been very annoying since noon, began to blow so hard that it was almost impossible to work with the instrument. So the line was stopped, and the party proceeded to camp. About five miles farther on, near the summit of Puncha Pass, ran about nine miles of line, stopping at 2 o'clock p. m.

The character of the country was much the same as that which we had been passing over for some days previous, except the Puncha Creek, which was a narrow cañon, with rocky hills and a scrubby growth of timber on each side of the creek.

*September* 26.—Camp was not moved to-day; the line was run up to and two and a half miles beyond camp, about two miles beyond the summit of the pass.

A splendid view of the San Luis Valley and of Sierra Blanco Mountains was obtained from a hill a little beyond the summit to the left of the road.

*September* 27.—Moved camp, and ran the line on down into the valley a mile beyond Kerber Creek on the San Luis Creek, making from our last camps about fifteen miles; the wind blowing so as to make it very annoying throughout the day. Got into camp about 3 o'clock p. m. Homans Park is a myth as a park *per se*. When at the summit of Puncha Pass, we were in the San Luis Valley.

The descent on the south side was much less than the ascent on the north side of the pass.

For further information would refer to the notes of the topographer, and to a barometric section from the South Arkansas to the level of the upper end of the San Luis Valley near Alder Creek, a small stream coming down from the hills to the west, and emptying into San Luis Creek.

There is an excellent wagon-road over this pass, which road extends on into the South Park and thence to Denver, and over which there is a very considerable amount of travel and freighting.

From the fact of the country being townshiped and sectionized from this point on the San Luis Creek, on down the valley, and on account of the intensity of the wind in the valley and the sandy road over which we should travel in going to Fort Garland by the east side of the valley, I determined to stop the line at this point.

*September* 28.—Continued our march to Fort Garland by the east side of the valley, crossing San Luis Creek about five miles below our camp, and keeping along parallel with and two or three miles from the base of the Sangre de Cristo Mountains.

There are numerous creeks running down from these mountains and sinking in the sand at distances from the mountains varying with the season. The first of these which we crossed after leaving San Luis Creek was Cotton Creek, about two miles from the crossing of the former. The next, about nine miles farther on, was Rita Alto, where we camped.

*September* 29.—Continued our march, crossing San Isabel Creek five miles out, and three miles farther the Cristina, both dry at the crossing of the road, but nearer the mountain contained plenty of water, as also there was farther out in the valley, where it appeared to rise again.

Three miles farther we came to another creek which we followed up toward the mountain, to water, wood, and grass, where we proposed to camp. But after waiting till late in the afternoon for our wagon we discovered that it had missed our trail and gone on. There being no water for seventeen miles, and sand a foot deep over a great part of the distance, we knew that a night march was inevitable. As our blankets and rations were all in the wagon and we had eaten nothing since breakfast, and our animals having had several hours rest and grazing, the best thing to be done was to move on. So at 5 p. m. we started. Fortunately for us, there was a moon, and we could follow the road and the track of the wagon very well. But such a road for fifteen miles I never had seen equaled for the depth of sand.

We crossed the dry beds of three streams marked by skirting of cottonwoods in the first five miles, all containing water nearer the mountains. The road then conducted us over a sandy waste by the southwest of the sand-hills mentioned in the reconnaissance to the Musca Pass. About nine miles from the last of the three belts of timber passed we came to a fourth, marking the course of the stream coming out the Musca and Sand-Hill Passes, which unite a mile from Musca Pass and sink at that point, so there was no water where we crossed it some four miles farther out in the valley. After leaving this skirt of timber the road improved a little, sand not quite so deep, and in a couple of miles crossed a brisk-running stream without any timber whatever, and a mile or two farther found the wagon at a similar stream, where it had stopped about dark, and where we found it at 10 o'clock p. m., after a most tiresome march of five hours.

The two last streams are from the mountains between Musca Pass and Zapato Creek, and sink near the base of the mountains, rising again from three to four miles out from the mountain, to the west of the road from Fort Garland to Musca Pass.

*September* 30.—Determined to go out into the valley to-day and ascertain if there was a lake there, and, if so, how large; so directed camp to be moved about five miles, to the crossing of Zapato Creek, where the road we were traveling intersected the one from Fort Garland to Musca Pass. After riding about five miles out into the valley, a little south of west from our camp, found some marshes and sloughs into which the stream that we camped on and had followed down emptied, and a mile farther south and a little west found the large lake, which is about two miles long and a mile wide. The water in the lake and in all the marshes is very alkaline. From the lake southwest, toward Sterrit's ranch, on the road from Garland to the Rio Grande, is a continuation of sloughs and marshes, as there are also toward the north and northwest, to the sinks of Saguache and San Luis Creeks.

Perhaps some information of importance with regard to this valley could be obtained from the plats and maps in the land-office at Pueblo, and in the office of the surveyor-general of the Territory at Denver.

A company enfranchised by the territorial legislature collect tolls and maintain a good wagon-road over the pass, the principal works having been done on the southern approach.

*October* 1.—Marched to Fort Garland, and, discharging rodmen Pimper and McIntyre, await transportation to Pueblo.

Very respectfully, your obedient servant,

JAMES BASSEL,
*Second Assistant Engineer.*

H. G. PROUT,
*Chief Civil Assistant Engineer,*
*In charge Reconnaissance in Ute Country.*

## ROUTES TO THE UTE COUNTRY.

It being deemed advisable to insert at this point a general view of routes examined, and also of all routes of which information has been gained in any reliable manner, the following brief description is believed to be reliable, and certainly is entirely unbiased by any other consideration than the desire to carry out the object of the expedition, namely, clear and truthful description.

*San Juan mining-district.*—In view of the importance of the mining interests recently developed in this district, the subject of communication is of great importance. In the district, opinion is divided, many favoring the opening of a road from Pagosa via the old Spanish trail to its crossing of the Animas River, and thence up the valley of that river by the trail by which we descended from Baker's Park. The weight of opinion, however, among those best qualified to judge, seemed to be in favor of a wagon-road being constructed from Del Norte up the valley of the Rio Grande, crossing the main range by the Cunningham Pass. Although generally admitted that as favorable a grade could not be had by this route, it is nevertheless possible to build a road practicable for wagons with light loads, and with a fair probability of the work being completed in a short time and at reasonable cost. This is certainly the shortest route and makes more direct communication with present outlets, which may be summed up as the Denver and Rio Grande, Atchison, Topeka and Santa Fé, and Kansas Pacific Railroads; the total distance to Puebla, the present terminus of the Denver and Rio Grande Railroad, via Del Norte and the Sangre de Cristo Pass, being 226 miles; while by way of the Lower Animas and old Spanish trail via Pagosa and the Sangre de Cristo the distance is not much less than 300 miles.

Many of the miners in this region are speculating on the probability of a railroad being constructed across the mountains in or near Southern Colorado, and should a practicable route be found into the San Luis Valley, a great many mountain-men assert that even an extension westward is possible near or south of the old Spanish trail. However this may be, I am certain that no railroad company which meant to pay dividends would ever do more than send one scout into the terrible country around Baker's Park unless to build a branch road for mineral traffic up the valley of the Animas, and this would have to be constructed with very heavy grades.

From the country seen on our two expeditions I have no hesitation in asserting that a practicable east and west railroad-route is not to be found in this region between Grand River, latitude 38° 30′ and 37°.

Since our return the wagon-road up the Rio Grande has been constructed as far as Antelope Park, with favorable prospects of a speedy completion across the pass into Baker's Park, the territorial legislature having granted the privilege of collecting tolls to the company formed by the miners of this region.

*Passes across the Uncompahgre Mountains from the Rio Grande to Lake Fork and its tributaries.*—The only two passes of which I have any knowledge are the pass at the head of Clear Creek, to the Lake Fork of Grand River, and a pass seen from this, which appears to be at the head of a branch of Clear Creek, (the one first crossed after leaving Camp 42 on Lake Mary,) and a stream on the western slope, which I suppose to be the head of the stream we named "Soda Creek." The first of these is described elsewhere in the report of our journey across it. The other one, which I shall name the East Pass, is described by a miner, who for a time acted as our guide, as a very low and easy pass on both sides of the mountains, with the exception of a short distance on the Clear Creek side, where the ascent is stated to be very steep. Neither of these passes would be of any utility for railroad-purposes, as the only outlet westward would be down the stream to Grand River, and a shorter and better way of getting there would be by way of Cochetopa Pass. For scouts and military purposes both these passes may be classed as good ones, there being an abundance of grass and fuel, and the country is more open than usual in this region.

Without actual knowledge I am of the opinion that the eastern pass would be a near and good route from the Upper Rio Grande to the Los Pinos agency. A good wagon-road could be constructed over either pass at moderate cost.

*Passes from plains to San Luis Park, Sangre de Cristo, Vita, Muddy Creek, Musca, and Sand-Hill Passes.*—Of these, Sangre de Cristo is the only one I have traversed in its whole extent, and is so well known that a description is unnecessary. A practicable railroad-route is said to have been located through the Vita Pass by the engineers of the Denver and Rio Grande Railroad, which indicates that moderate grades can be found through passes which, in their natural condition, are impassable for travel, as this is said to be. This remark also applies to the Musca Pass in so far as examined by us, through which an excellent wagon-road could be constructed at little greater cost than that of removing loose surface-bowlders and cutting away timber, as stated by Mr. Bassel in his report of survey of Musca Pass. This would be a much shorter route from Pueblo to Del Norte than via the Sangre de Cristo Pass, but only in the event of a road being graded across the swamp and sand of San Luis Desert.

The Muddy Creek Pass is that which trends against the head of Sangre de Cristo Creek west of the pass known as Sangre de Cristo Pass. The grade of this pass is stated to be much easier than by the Sangre de Cristo, the distance being somewhat greater.

The Sand-Hill Pass is much used by the Ute Indians; from the information I obtained I am of opinion that it is of little use for wagon-traffic, as it is very steep, and its southern outlet in San Luis Park is completely estopped by the sand-hills.

*Cochetopa Pass.*—I have no doubt but that a practicable route for a railroad could be found crossing the main range at or near this pass, which is the lowest and has the easiest approaches on both sides of any we saw in this region.

The most difficult portion of this route seen by us would be that between the junction of the Tumitchi and Los Pinos Creeks and the Cochetopa River. Down the valley of this river to its junction with Taylor, (below where it is known as Grand River,) there is no obstacle whatever. The country beyond is described in the report of Gunnison's expedition.

*Passes from the valley of the Arkansas to the head-waters of Grand River and via the Puncha Pass to San Luis Park.*—The only pass from Grand River to the Arkansas Valley examined by us is the Red Mountain Pass, between the Lake Fork of the Arkansas and a small tributary of Taylor River. This pass may briefly be described as impracticable for anything except saddle and pack animals, and impassable in the fall and until late in the spring.

The Puncho Pass, from the valley of the South Arkansas to Homan's and the San Luis Park, affords easy communication, a substantial bridge having been constructed across the South Fork of the Arkansas at the entrance of the pass and a good wagon-road extending for about seven miles to the summit. The cañon of Puncha Creek, along which the road extends, is narrow and tortuous; the creek is small, and is bridged in several places. On the south the road is good and the descent is easy into Homan's Park, which is merely an extension of the San Luis Valley. The best grade on the northern approach is about 240 feet per mile.

The route to the west extends by a first-rate road on the west side of the park to Saguache and the Los Pinos agency.

To reach Fort Garland by this route, following down the margin of the park to Del Norte and thence east, is preferable to attempting the shorter line direct from Homan's Park through the sand-hills to the east end of the park.

DONALD W. CAMPBELL, *Assistant.*

## APPENDIX A.

*Description of instruments and methods.*—The instruments were theodolites by Alve, of Saint Louis, 5-inch limb, two verniers, reading to 20″; their telescopes were 8½″, focal length 1½″, aperture provided with a limb for reading vertical angles read by a vernier to single minutes; these were fitted for use as stadia instruments by inserting vertical and cross hairs. There were three of the latter, giving two unequal intervals. For each wire interval a stadia rod was graduated independently. Each rod was graduated by ascertaining the space covered on it at a distance of 1,000 feet, by the wire interval for which it was to be graduated, and subdividing this space with points for each five feet. The several rods were graduated to measure extreme distances of from 1,800 to 2,600 feet, and were read by the instrumentman. The stadia instruments served to determine the linear distances; the direction of the line was kept by instrumental azimuths, the magnetic bearings being always read as checks. The azimuth was carried forward by taking back-sights and fore-sights at each station. The stadia rods served as signals for the back and fore sights, and the length of each course was read from each end when the fore and back sights were taken for azimuth, and the mean of the two readings used for the length. Whenever there was a marked difference of level between two consecutive stations, the angles of elevation or depression of the telescope was read at each station, and with the mean angle the horizontal distance was obtained by the aid of the valuable tables computed by Noble and Casgrain. The results obtained with these instruments were, as a whole, good, the closing being small even on long lines, for instance, the two separate lines run from Pueblo to Fort Garland differed only thirty-eight hundredths of a mile from each other in a mean distance of 81.33 miles. Their chief defect was the smallness of field and deficiency of power, making their use a severe task to the eyes and requiring an unnecessary number of sights in open country.

It is thought that the same instruments, mounted with larger and more powerful telescopes, and used in conjunction with a double target-rod of a pattern similar to that known as the "New York" rod, and brightly painted for self-reading, on near sights, would give still better results than were obtained. There is no doubt that, in a rough, mountainous country, carefully-made stadia-measurements are far more accurate than such as can be made by ordinary chaining with ordinary chain-men, and when the chain-men are very ordinary, as is too frequently the case, the superiority of the stadia is very great.

Considerable differences in results in damp weather were observable where the cross-wires were not made from the web of the "wood-spider," as was the case with these instruments when turned out by the manufacturer, the wires of which were of the web of the common house-spider, and would lengthen and "sag" when we met with humid weather on the Arkansas. One instrument (the wires of which had been refilled with the web of the wood-spider) was much more trustworthy, and in this connection I think that it would be advisable to have the stadia-wires adjustable and not permanently fixed as these are, for in the event of an accidental breakage of wires the new wires could be easily adjusted to the rods, while had such an accident occurred on our expedition it would have been necessary to regraduate the rods, a tedious and inconvenient operation, in such a country, if done permanently, and liable to change if done with colored chalks. An important consideration is to keep down the weight of the instrument, which has to be carried on the shoulder on mule or horseback over difficult and often dangerous trails, and through miry forests, in which Government mules develop a penchant for crushing their riders' legs against tree-trunks. At these times the instruments must be handled easily to prevent their being broken. If it is possible, I think an instrument made of aluminum or aluminum-bronze would best meet the requirements of this service. Mr. Hamilton, a member of the firm of T. H. Whally & Co., instrument-makers, of New York, who have the repairing of the Government instruments at Willet's Point, described a French instrument captured from the rebels during the war and sent to them for repair, which, if it at all answers to the description given, would be invaluable for filling in details of these topographical surveys. As I understand, the instrument simply described is a telescope properly mounted, having its object-glass halved, the halves being of different focal length; when pointed to a distant object each half of the object-glass is so adjusted that the object is clearly seen through it, when the distance of the object is read off in meters on a scale attached.

## APPENDIX B.

*Geological observations made between Pueblo and Fort Garland, Colorado Territory.*—Pueblo is situated in the valley of the Arkansas River, on the margin of the great plains of the West. The vicinity is underlaid by a deep formation of drift, beds of slate, shale, marl, and gray limestone. The bluffs of the river are low, have a common level, and indicate an ancient shore-line. The route to Saint Charles lies over undulating prairie with the plains on the left. On reaching the Saint Charles River the underlying rocks were found to be of an ashy-gray impure limestone, alternating with thin strata of shale or marl. In the bluffs is an exposure of ninety feet of these formations, extending down to the water of the river.

The upper strata would make building-material for ordinary structures and fencing; they contain a few *Inoceramus problematicus*, *Ostrea congesta*, and some small species too obscure for identification; and many fragments of what appear to have been a large *Inoceramus*.

The valley of Saint Charles is about ¼ mile in width, and the stream too inconsiderable to be called a river.

The soil on the Mésa, between Pueblo and Saint Charles, is sandy, of a light-brown color and at some places contains an excess of the mineral salts. A good growth of *Helianthus*, remains of last year's crop, indicate a good productive capacity when well watered.

In the valley of Saint Charles are numerous farms well cultivated and producing good crops of wheat, barley, rye, and oats. When there is a lack of rain the stream is used in irrigation.

One mile southwest of Camp 1 is a ledge of soft black slate 35 feet thick; contains numerous large septaria, often three feet in diameter, which would probably make good hydraulic cement. Some of these concretions contain large beautiful crystals of *calc* spar. This formation belongs below the series in the bluffs of Saint Charles River.

*Organic remains.*—The same as yesterday with the addition of a large *Ammonite.* The surface between Saint Charles River and Muddy Creek is broken into a system of deep narrow valleys and ravines, well adapted to shelter stock, and good only for grazing. The valley of Muddy Creek is nearly ½ mile in width, the bottom somewhat undulating, with a few farms above and below the line aided by irrigation.

From Muddy Creek to the crossing of Greenhorn Creek, the equivalent of the solid formations observed in the vicinity of Saint Charles River Valley occur, with additions, in the eastern bluffs of Greenhorn and its tributaries.

The slate is augmented in volume with the following additions, descending:

No. 1.—Twenty feet dark bluish-gray shaly limestone, alternating with like-colored marly clays; containing *Inoceramus problematicus*, Pinna, and a few small shells not identified.

No. 2.—Two feet dark-blue slaty limestone.

No. 3.—Seventy-five feet plastic clays and marl.

No. 4.—Two feet like No. 2.

No. 5.—One hundred and fifty feet slope with out-crops of slate.

From Muddy Creek to the crossing of Greenhorn Creek, a distance of five miles, the surface is much broken. The soil is good, but dry, and would require irrigation to make it produce. for which there are no facilities, except on the creek-bottoms, where a few farms are cultivated.

From Greenhorn Creek to Apache Creek, a distance of six and a half miles, the line crosses a level surface, the margin of the great plain on the east, and the Greenhorn range of the Rocky Mountains within twelve miles on the west. The soil here, too, is good, and like that crossed in the first part of the day's march, is too dry, with no water for irrigation, but for grazing it is unexceptionable.

These conditions exist unaltered between Camps 3 and 4. Farms under irrigation are found in the Huerfano Valley. Grazing, however, is the principal element of husbandry, but the appearance of the flocks and herds shows that this is very poor. From Camp 3 passed over a series of out-crops similar to No. 5, of the last-given section, but not sufficiently uncovered for a definite classification. In the mountain, however, 800 feet above these out-crops, I observed the equivalents of the gray limestone found in the bluffs of the Saint Charles River.

The different formations hitherto noted may be approximately classified in the following order, descending:

No. 1. Ninety feet ashy-gray, impure limestone; the lower portions weathered, irregular fragments. Organic remains: *Inoceramus problematicus*, *Ostrea congesta*, a large *Ammonite*, and fragments of what might have been a large *Inoceramus.* Localities: In the bluff of Saint Charles River; capping the high bluffs of Muddy Creek; along Greenhorn Creek and its tributaries; on the slope of Greenhorn Mountain range, 800 feet above the general level of the plain.

No. 2. One hundred and twenty-five feet black, brown, and blue slate, shale and marl, and large septaria, often two feet in diameter, and containing large crystals of *calc* spar. Locality the same as the preceding, except the mountain-slope.

No. 3. Twenty feet dark-bluish-gray shaly limestone, alternating with dark-blue marly clays. Organic remains: *Inoceramus problematicus*, Pinna, and a few small species not determined. Localities: In the valley of Muddy Creek, below the road, and near the junction of Greenhorn and Muddy Creeks.

No. 4. Two feet blue slaty limestone.

No. 5. Seventy-five feet slate, clay, and marl.

No. 6. Two feet like No 4.

Locality: Nos. 4, 5, and 6 are found in the valley of Muddy Creek, below the road.

No. 7. One hundred and fifty feet or more slope with outcrops of slate and marl. Locality: This formation is probably several hundred feet thick, and may be the upper portion of the outcroppings noticed between Camps 3 and 4. It gives the peculiar uniform slopes of the valley of Muddy Creek below the Trinidad and Fort Garland road.

Two miles above Camp 4 the Huerfano leaves the mountains through a cañon of brown sandstone. These formations were much distorted, and may be traced high up in the valley of the Huerfano, where a series of these or similar formations are in great force, and in a less disturbed condition. This valley must have been closed against the Cretaceous sea in which the strata of that age were deposited along the eastern slope of the mountains, as remains of that system could not be found. Fragments of limestone, however, are strewed on the slopes of the mountains at intervals up to near the summit of the Sangre de Cristo Pass, but contain no organic remains, and have the characteristics of fresh-water rocks. The high peaks flanking the eastern approaches to Sangre de Cristo Pass are of a species of porphyry.

Visited the Gray-back gold-mines, situated about 750 feet below the summit of the pass, three miles from the mouth of a stream that flows from the right into Sangre de Cristo Creek, about six miles below the summit. Fifteen men were engaged in washing. The gold is obtained in flakes, and the yield is from three to five dollars per day per man. In this vicinity is found a broken ledge of limestone of the Carboniferous period laying against granite, from which were obtained the following organic remains: *Cyathophyllum, Productu egicostatus, P. semireticulatus, and Spirifer cameratus.*

The lower slopes of the valley are mostly composed of red disintegrating feldspathic granite, with some *gneiss* and mica slate.

On the high elevations on the right side of the valley my assistant collected some specimens of *Dolorite Trap* and several different varieties of *Porphyry.* On the right slope of the valley, two miles below Camp 5, is a slide of 150 feet of metamorphic light-gray shale, with hard, compact, dark-blue concretions, containing *Productus cora, Spirifer Kentuckensis, Spirigera subtilita.*

Three furlongs lower down the valley is a ridge of limestone, sandstone, and shale; much changed by heat, and tilted on their edges. Found no organic remains. For seven miles below the right slope of the mountain is strewed with *débris* of like rocks observed in the ridge, and extending up to a much higher elevation.

The lower slopes of the valley, for five miles, are mostly composed of granite, gneiss, and mica slate. These are traversed by veins of quartz; thence to Fort Garland, the outcrops and contour of the surface indicates a sandy-clay formation several hundred feet thick, underlaid and supported latterly by granite rocks in many instances.

*Geological description. Examination of the Musca Pass from Fort Garland to Huerfano Valley, by F. Hawn. geologist. Ute reconnaissance.*

The foot-hills in the vicinity of Fort Garland, extending from Sangre de Cristo Valley to the south point of the Sierra Blanca, are covered with an indurated sandy clay mixed with fine gravel. It is sometimes partially stratified, with shore-marks on its surface. The formation is several hundred feet thick. and points to a period when the San Luis Valley was a lake. The slope along the foot of the west side of the Sierra Blanca contains among other formations the following: quartzite, jaspery quartzite, feldstone porphyry, trachyte-trachy, dolerite, hornblende, slate, and greenstone.

The approach to the Musca Pass from the west is narrow and tortuous. The walls are abrupt and craggy, composed of granular quartz feldstone, quartzose, porphyry, argillaceous shale, metamorphic limestone, trachyte, trachyte porphyry, and feldspar. These are much curved, distorted, and tilted. On the east side of the pass surface deposits hide the character of the rocks until a descent of about 550 feet brought in view a coarse, dark-brown sandstone in thick beds. In the gorges of the Huerfano Valley the sandstone is seen in ledges of 300 feet, and the strata in horizontal position.

Between the Musca Cañon and the entrance of Sand Hill Pass to the north extends a ridge of loose sand, about 900 feet in height and five miles long, obliquely out in the San Luis Valley. Like the waves of the ocean it stretches, without a single green growing on its surface constantly shifting from the wind. It owes its origin, however, to causes more potent than this.

*Table of marches and altitudes.*

| Date. | Camp. | Distance. | Barometer. | Approximate altitude. | Soil. | Timber and vegetation. |
|---|---|---|---|---|---|---|
| | | | | *Feet.* | | |
| Aug. 12 | 1 | 8 | 22.633 | 7.394 | Gravelly | |
| Aug. 13 | 2 | 9 | 22.691 | 7.270 | Sandy and arid | Artemisia, cacti, scattering; conifera and aspen. |
| Aug. 14 | 3 | 11 | 22.388 | 7.641 | | Conifera; thick. |
| Aug. 15 | 4 | 1.5 | 21.843 | 8.272 | | |
| Aug. 16* | | | 21.230 | 8.996 | Vegetation thrifty | Spruce fir; aspen; yellow pine. |
| Aug. 17 | | | | | Pasturage good | |
| Aug. 18 | | | | | Pasturage better on east side. | Scattering conifers. |

*Engaged in examination of the cañon on east side.

*Geological observations continued between Fort Garland and Animas Park.*—Fort Garland is situated on the eastern margin of San Luis Valley, midway between Sangre de Cristo and Ute Creeks, and one mile distant, with Sangre de Cristo range on the east, and Sierra Blanca on the northwest. The surface in the vicinity is deeply covered with drift, composed of cobble-stones of primary formations, found in the mountain-ranges on the north and northwest. Vegetation, except *artemisia*, is always scant, except in limited areas in the valleys on either side. Timber, of a good quality of yellow pine, may be obtained six miles above in the valleys, and piñons and cedar suitable for fuel in the foot-hills near by. Building-stone may be had in the foot-slopes of Sangre de Cristo range, three miles distant, but of a quality that would require expensive dressing. On leaving Fort Garland the course pursued is nearly due west over San Luis Valley, which has the appearance of the western plains, except in verdure; the ground is occupied mostly by sage (*Artemisia tridendata*) *cacti* and greasewood, with a scanty growth of tuft-grass between. The soil is of a sandy loam, but in some portions the sand predominates to a degree amounting to sterility. In other localities, of considerable areas, the ground is boggy, with rank growth, of course. Here the dry ground and plants are incrusted with an alkaline mineral, much relished by cattle, and serving them in the place of salt. In the vicinity of Sterret's ranch are a number of weak, brackish springs, elevated ten feet above the common level of the surface. The waters discharged are absorbed by the adjacent plain, serving the purpose of irrigation.

The springs bring up a silicious mud, and probably in the accumulation of this sediment these elevations were formed.

Upon approaching the Rio Grande the surface becomes gravelly.

Three miles above Camp 12 we leave San Luis Valley, and continue up the valley of the Rio Grande. When the stream issues out of the mountains it is at this time about 100 feet in width, with an average depth of 5 feet, and a velocity of — miles per hour. I am informed that it is now at its medium height. The channel, so far as my observation extends, is not more than 20 feet below the general surface of its banks and the plains in the vicinity. From the rapid fall, the waters may be led with facility on the adjacent lands and render irrigation comparatively inexpensive. Several small farms, now watered in this manner, produce good crops of wheat, oats, and barley of fine quality, with crude culture; and potatoes unsurpassed in yield and quality.

The rearing of sheep and neat cattle is now the predominant pursuit, and is conducted in the manner of the patriarchs of old, or nearly left to the providence of nature.

The Rio Grande where it issues out of the mountains is flanked on the left by a wall of basalt; this formation occupies the foot-hills of the valley to the close of the day's march.

The class of rocks in the valley between Camps 12 and 13 are observed in the slopes above Del Norte, changed somewhat in composition, and sometimes have chalcedonic crystals. The rocks in front of Camp Loma are a reddish-brown trachyte, and weather into angular fragments, while the high peaks in the rear are of trap-porphyry.

From the mouth of the valley to Camp Loma the valley contracts, and at the latter point ceases to be of any consideration in agricultural view, except for grazing to a limited extent.

Camp Loma is situated on the right bank of the Rio Grande, one mile below the junction of the main stream and South Fork, within a few hundred feet of the foot-hills of the mountain, and about ninety feet above the stream. The camp is abundantly supplied with good water by a ditch one-half mile in length. Good building-timber is found on the military reservation, and a further and abundant supply of good yellow pine may be had a few miles up the valley of the river. Good building-stone is abundant within four miles.

Between Camps 14 and 16, in the mountain slopes, on the left side, are escarpments of reddish-brown granite, large blocks of which have become detached from their ledges and obstruct our way.

The rocks that form the west walls of Rifle Cañon extend westward by nearly a right angle, thus facing the river, and are then the wall of a second cañon on the main stream, nearly a mile in length, the upper end opening out into Hot Spring Creek Valley. Following up the river from this latter point on an arc curving to the right hand, we come to the third cañon, or a narrow gorge, through the extension of the Rifle Cañon walls, which bears the name of Wagon-Wheel Gap.

Hot Spring Creek, to which reference has been made, is a southern confluent of the Rio Grande, is four rods in width, and averages one foot deep; but in its normal condition discharges a much smaller volume of water. One mile above the mouth are several thermal springs. The largest discharges about twenty gallons per minute, with a large amount of sulphureted hydrogen, which may be detected by the odor at a distance of one hundred yards. The water is probably little below boiling-point, (or 196° F. at this elevation,) is of a crystalline clearness, and deposits a blue sediment. The ground in the vicinity is covered with a white incrustation, which has a pungent, acidulous taste. The next spring in size discharges about eight gallons per minute, has a temperature of about 120° F., and deposits a large amount of oxide of iron sediment. Notwithstanding its temperature it is pleasant to the taste, and agreeable in its effects. From the romantic scenery and the dry, salubrious atmosphere, these springs are well calculated to become popular watering-places, and I regret that circumstances are such as to preclude me from securing specimens of these waters for analysis. Soon after passing up through Wagon-Wheel Gap, isolated masses of vitrified cherty limestone were found at the foot of the mountain-slopes on the left side of the stream. Several miles farther up the valley the river runs against a high bank of buff-colored clay, thinly stratified, and alternating with a hard indurated slate, of the same color and composition. This formation seems to attain a thickness of over two hundred feet, and the stratifications are in horizontal positions.

Fragments like these are traced along the granite slopes of the valley to Camp 17. The valley of Hot Spring Creek is one mile in width at the springs. The soil is passably good, but the climate too cold for general agricultural purposes, as the thermometer marked 31° F. at sunrise, and ice was observed at noon on northern slopes. The valley of the Rio Grande above Wagon-Wheel Gap soon expands to several miles in width. Scattering *cacti* and *artemisia* are found in some places, but, notwithstanding, good pasturage may be found for large herds.

Five miles west of Camp 17 is a ledge of hard strata of buff argillaceous shale, or slate, interstratified with like-colored clays in their laminæ. The ledge extends for a mile along the river, and measures, in some places, over 100 feet up from the water's edge, and by fragments I traced it up on the slope of the mountains to an elevation of 500 feet more. Above the exposure it seems to alternate, or is capped with coarse brown sandstone. Few or no organic remains are identified. A fragment of what might have been a *Pinna*, a cast of an orbicular shell too obscure for identification, and numerous impressions like the casts of *Fusylina*, or what might have been the foot-prints of a small reptile, were observed. These latter are so numerous as to cover entire surfaces of slabs, and the impressions are larger in the upper than in the lower strata.

Five miles above Camp 17 the valley contracts, and thence the bottoms or level portions are limited to the right side.

The Bristol Head Spur is a short and narrow range, with the valley of the Rio Grande on the east and Lake Mary Cañon on the west. The highest point is about 12,000 feet, and is the product of volcanic action. The highest peaks are trachyte, and the southern extremity of the range is porphyry. Patches of white and purple clay are seen on the west side

500 feet above the base of the range. For four miles above Camp 18 the valley is contracted, but then it widens out again, sweeping away toward the southwest around Bristol Head, and forms a park (Antelope Park) of many thousand acres of tillable land, much of which might be irrigated. But the climatic conditions incident to so high elevations in this latitude would probably prove unfavorable to the growth of a great range of agricultural products. For the purposes of grazing, as it is conducted here, it is even now of considerable value.

Three miles from Camp 19 we enter Antelope Park Cañon, a narrow gorge of some eight miles in length, with nearly a perpendicular wall on the right; and on the left, at the foot of an encampment, a steep slope affording precarious footing for our animals. The walls are from 100 to 1,200 feet in height from the water-line. In some places on the left the upper formation is a ferruginous scoria; lower down, porphyry, of close texture and handsomely variegated, on a dark violet ground, and at or near the base a dark earthy-brown trachyte.

Soon after leaving Antelope Cañon I found masses of conglomerates of partially rounded and angular fragments of such rocks as are found in place in the vicinity. The escarpments on the left of the valley are of red feldspathic granite, and patches of white clay were frequently observed high up on the slopes.

Leaving the valley of the Rio Grande in the vicinity of the Lost Trail and passing up the left slope of the valley over to the head of a valley leading back to Antelope Park, I found on the summit, when the barometer indicated 20.791 inches, or approximating 9,500 feet above the gulf, 15 feet of chalky-white, porous, crumbling limestone. About 600 feet lower, down in the valley, occurs a ledge of hard, compact, brown limestone, accompanied with gray shale. I found no organic remains in either, except what might have been the impression of wood in upper or white limestone.

A short distance above Camp 20 the valley of the Rio Grande widened and maintained an average of about half a mile, with boggy bottoms overgrown with willows. It would afford pasturage for a limited herd.

Northwest of Camp 21 is a formation of clay resting high up against the slope of the valley. The upper portions are of a bright purple and blue, but the larger portion at the base is green.

The space thus occupied is over 300 feet in height. These clays were rarely out of sight during the day, and often ranged high up in the mountains. The base of the mountain, as exhibited in the valley, is mostly composed of a beautiful red granite, and the high peaks of trachyte and other volcanic productions.

At or near Camp 22 the green clay of the preceding march is found in a slope of 75 feet, stratified, partially indurated, silicious, and weathers into plastic clay. It contains a large quantity of partially water-worn, calcareous, and arenaceous bowlders, as well as angular fragments of like characteristics.

I found no organic remains except a water-worn wood opal.

Fragments of these clays were constantly in sight during the day, often up at timber-line.

In crossing Hamilton Pass the ground was covered with snow.

Formations in the distance on a side of the mountain, uncovered, seem to be of igneous origin.

Timber-line on the eastern slope from one observation was 19,365 inches, or about 11,300 feet above the Gulf. Summit of the pass from one observation was 18,980 inches, or about 11,966 feet above the Gulf.

Crossed over to the Pacific slope; timber-line from two observations was 19,640 inches, or 11,022 feet above the Gulf.

The rocks, after leaving Camp 24, were all of Plutonic origin. In Rocky Gulch I observed a bowlder of galena two feet in diameter.

Passed over gulches and through ravines strewed with fragments of feldstone, some of which had attached galena, copper, and iron pyrites in quartz gangue.

Baker's Park is merely a widening of the valley of Las Animas for five or six miles, with about a half mile maximum width.

Proceeding down the Las Animas Valley, the rocky walls on the right side are of feldstone, traversed by numerous veins of quartz, many of which contain minerals of different kinds.

Baker's Park has a large area of good grazing-land, and its native grasses furnish forage for many heads of stock during the summer. The narrow valley connecting this park with Hamilton Park is too limited to be of much use.

Here one branch of the corps continued the reconnaissance down the Las Animas Valley, and Laurens Hawn, assistant geologist and meteorological recorder, was detailed to take charge of these branches on this route, and the report of his researches and field-notes are herewith submitted, with my approval.

F. HAWN,
*Geologist and Meteorologist Ute Reconnaissance.*

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*Geological notes made on the Ute reconnaissance during examination of the Animas River, by Laurens Hawn, assistant geologist and meteorological recorder.*

Ascending from the foot of Hamilton Park, at the entrance of the Las Animas Cañon, the rocks are principally granitic until an elevation is attained on the slope of a valley of some eight hundred feet, when blue limestone appears.

This, being exposed and forming a table about eleven hundred feet above the river, I traced for several miles. The formation was somewhat altered by heat. I made the following section near Camp 27, on and above the line:

Nos. 1 and 2, 465 feet of sandstone.

No. 3, 50 feet of gray limestone; no fossils found.

No. 4, 300 feet of coarse sandstone.

No. 5, 30 feet of bluish-gray fossiliferous limestone, weathers into angular fragments.

Organic remains: *Cimoiden; Productus equicostatus; I. reticulatus; Spirifer Kentuckensis.*

No. 6, 250 feet of greenish micaceous sandstone.

No. 7, 10 feet or more of bluish-gray limestone; no fossils found.

No. 8, 90 feet or more of greenish micaceous sandstone.

No. 9, 200 feet slope; no outcrops.

No. 10, 8 feet or more of coarse white sandstone.

No. 11, 5 feet of bluish gray limestone.

No. 12, 200 feet of slope; no outcrops.

No. 13, 10 feet of brown fine-grained sandstone.

No. 14, 50 feet of bluish-gray fossiliferous limestone, weathering into angular fragments.

Organic remains: *Productus reticulatus; P. Semireticulatus; Spirigera inflatus; S. Maconensis; Spirifer lineatus.*

No. 15, 100 feet slope; no outcrop.

No. 16, 10 feet flesh colored limestone, weathering into angular fragments, occasionally seams containing crystals of spar.

No. 17, 15 feet of black marble.

No. 18, 3 feet of whitish-gray marble.

No. 19, 6 feet of white limestone, with a bluish tinge.

No. 20, 15 feet of a reddish-brown sandstone.

No. 21, 10 feet of whitish-gray marble.

No. 22, 3 feet of reddish-brown sandstone.

The dip of this series is about 10° west. This section carried me down to the walls of the Las Animas Cañon, which here are about 1,000 feet high. They are granitic at this point. The river itself is inaccessible. In a gulch half way between Camps 27 and 28, I found cropping from beneath blue limestone about 8 feet of buff limestone. This rested upon coarse brown sandstone, of which I could not determine the thickness. From this point I lost trace of my section. About one mile above Camp 28 I made the following section west of the line and in descending order:

No. 1, 20 feet of bluish-gray fossiliferous limestone.

Organic remains: *Productus reticulatus; Spirifer lineatus; S. Kentuckensis; Spirigera Maconensis.*

No. 2, 15 feet or more of sandstone.

No. 3, 30 feet of bluish-gray limestone; fossiliferous.

No. 4, 50 feet of coarse sandstone.

No. 5, 20 feet of bluish-gray limestone; no fossils found.

No. 6, 40 feet or more of sandstone.

The wall rock of the creek at Camp 28 is composed of blue limestone, but being isolated or unaccompanied by the other members of the series, its identity remains in doubt.

Nothing definite is determined between Camps 28 and 29, owing to the deep irregular cañons, except that the blue limestone and the brown sandstone crop out in several places; but at Camp 29, in the bluff on the west, blue limestone, with the shale beneath it, is exposed. My section is not sufficiently classified to give these formations their proper places.

At a point on the line a mile south of Camp 29, the following section occurs, commencing at an elevation of 900 feet above our route, as follows, descending:

No. 1, 75 feet of hard, blue-gray fossiliferous limestone.

Organic remains: *Productus costatus; P. cord.; P. reticulatus; Spirifer lineatus; Spirigera subtilita.*

No. 2, 75 feet coarse sandstone, mottled.

No. 3, 150 feet of bluish-gray limestone, shading into white sub-crystalline, and resembles marble.

Organic remains: *Productus reticulatus; Spirifer Kentuckensis; Spirigera subtilita.*

No. 4, 111 feet coarse, reddish-brown sandstone.

No. 5, 50 feet of hard, blue, sub-crystalline limestone, shading into gray; no organic remains found.

No. 6, 30 feet reddish-brown sandstone.

No. 7, 30 feet of bluish limestone, shading into a bluish tint; no organic remains found.

Nos. 8 to 12, 720 feet of bluish-gray and mottled sandstone.

No. 13, 150 feet of slope.

No. 14, 20 feet of limestone, varying from white to blue, and breaking into angular fragments.

No. 15, 25 feet calcareous sandstone.

No. 16, 3 feet or more of fossiliferous cherty limestone.

In this formation recur the sub-carboniferous fossils: *Crinidea, Productus reticulatus, Gorgonia, eumphalus latus*, and *cyathophylum*.

The strata of this section dip west to an angle of about 10°. From this point to Camp 30, in several places, cherty limestone appears, but its position in the section or its volume is not determined. In consequence of the press of time and other duties, the thickness of the different formations may not be correctly estimated, but enough is determined, together with the organic remains obtained, to prove that here at least are extensive beds of carboniferous rocks.

The walls of Cascade Creek, at Camp 30, are composed of gray and cherty limestone. This formation probably belongs beneath the section last recorded, since that series lay in the cliffs a short distance to the right of the point. (See No. 16 of last section.) In this limestone were found the following organic remains: *Crinoidea, Productus reticulatus, Gorgonia, euomphalus latus*, and *cyathophylum*. This formation may, with propriety, be referred to the sub-carboniferous, as I believe the *euomphalus latus* is never found above that division. So far it is definitely classified. Other formations came in below, and, though not defined, are believed to belong to the same division. On higher ground I traced these formations in their relative position to Camp 31.

Between Camps 30 and 31 the route lies over a high plateau, exceedingly fertile and well watered by numerous springs, which in places form marshes.

The grass and other herbage is rich and abundant.

The same formations continued in the bluffs between Camps 31 and 32. The sandstone becomes more compact and less micaceous, and frequently changes to a reddish-brown, caused by heat.

Descending from the high plateau to Animas Park, the strata dip south at an angle of 15°. Numerous thermal springs flow from the limestone formations near Camp 32, in which I recognized sulphur and iron and other minerals not determined. These springs are small, the largest discharging not more than five or six gallons per hour. Some of these waters are pleasant to the taste and in their effect. After leaving the high plateau the soil becomes dry and sandy, except when watered by an occasional spring, and shrub-oak becomes abundant.

Below Camp 32 the dip carried the series beyond recognition. About three miles below Camp 32, on the summit of the cliffs to the right and parallel to the river, appears a dark and micaceous sandstone, fine and compact, characteristics differing from those in the series before described.

The volume of this red sandstone increases in thickness as it dips south, by the accumulation of strata on the top, until it equals about 1,000 feet in thickness, after which it is soon carried below the surface of the park, by the dip caused by subsidence or an extensive slide prior to the present order of things.

The distance from where it first appeared to where it disappeared is about five miles. This formation is also in the cliffs on the opposite side of the river. For the want of time, and owing to the rapidity of the changes of the cliffs in which the red sandstone first appears, I was unable to determine the characteristics of these cliffs, but believe the upper and higher portions of the slope of the valley likewise sandstone of a different nature. The red sandstone slide to which I have referred left exposed in the face of the cliffs against which it had rested strata of white sandstone. At this point a perpendicular cañon is cut through this cliff. Down this cañon I traced the white sandstone just mentioned to a creek about two and a half miles above Camp 33, when I obtained the following section in descending order:

No. 1, 5 feet of yellow sandstone.
No. 2, 15 feet of blue shale.
No. 3, 20 feet of hard fine white sandstone.
No. 4, 3 feet of shale and sandstone.
No. 5, 1 foot of coal.
No. 6, 20 feet of hard, fine-grained white sandstone.
No. 7, 6 feet of blue calcareous sandstone.
No. 8, 10 feet of fine-grained white sandstone.

The dip of this series is about 10° southwest. Judging from appearances, the soil of Animas Park is not very prolific. This is probably owing to the want of rain, for portions that receive moisture from the streams have a luxuriant vegetation.

The surface and shallow troughs of the stream would render irrigation of the greater part of the park comparatively easy and inexpensive. There is a scanty growth of cotton-wood and willow on the river banks and its tributaries running through the park, while the surrounding hills are covered with pine and an inferior growth of oak, serviceberry, wild oats, perennial flax, and a large variety of flowers abound. Vegetation indicates an isothermal of Northeastern Kansas.

(See, also, meteorological observations.)

Although the several formations included in the several sections, except one, are of one undoubted coal-measure origin, and spread over a large area, and although upon closer examination thicker and workable beds of coal may be found, no extended beds will be rendered available, as these formations lie against the mountain-slopes, which are granitic, preventing much lateral extent, except, perhaps, in the vicinity of the Animas Park, where the mountains dwindle into hills, some of which are of carboniferous origin.

*Table of timber, distances, altitudes, and camps.*

| | | Bar. | Alt. | Dist. | Camp. |
|---|---|---|---|---|---|
| June 14, | heavy growth spruce and aspen..... | 20.67 | .... | 3 | 27 |
| 15, | same, but heavier.................. | 20.78 | .... | 5 | 28 |
| 16, | same, add few fois................. | 20.80 | .... | 3½ | 29 |
| 17, | same............................... | 20.85 | .... | 3½ | 30 |
| 18, | same, add maple and cotton-wood.... | 21.72 | .... | 4½ | 31 |
| 19, | pine, cotton-wood, choke-cherry, oak. | 23.46 | 6,412 | 10¼ | 32 |
| 20 | | 23.51 | 6,376 | 12¾ | 33 |
| | | | | 42 | |
| | Return................................... | | | 42 | |
| | | | | 84 | |

### *Report of the geological survey of the Las Animas mining-district, by F. Hawn, geologist of the Ute reconnaissance.*

This district comprises an area of about one hundred square miles, including Baker's and Hamilton Parks and their lateral valleys, and of the Las Animas River.

Hamilton Park is situated on the west side of the district, as now developed, and includes about 7,000 acres.

Mineral Creek enters the southwest corner of this park, presses along the west slope of the mountain for near two miles, and enters Las Animas River.

From the mouth of the creek to the entrance of the valley above, the mountain slope is mainly composed of trap. Above this the slope on the left-hand side going up is covered with surface-deposits that hide the main formations, but I believe them to be likewise trap.

At the entrance to the valley on the right side going up is an escarpment several hundred feet in height, composed of cellular micaceous quartzose formation in thick beds and of a ferruginous aspect. The cells contain a fine, ashy-brown silicious dust, and its micaceous characteristics might rank it among gneiss.

Farther up the stream, near the junction of the South Fork, the summit is covered with different-colored silicious matters, blending the hues of orange, purple, and crimson.

The North Fork of Mineral Creek is a mere gorge. It was once filled to timber-line with recent formations, and a sandstone and coarse ferruginous conglomerate yet occupy portions of its lower slopes, while the higher levels are of a yellow-argillaceous clay and slate.

These modern remnants cover most of the surface, but at a few points I observed feldstone and other trappean varieties, and in the higher peaks volcanic deposits. No extensive mineral veins had been discovered in this valley, as "prospecting" is rendered difficult in consequence of the modern deposits covering the slopes.

The South Fork of Mineral Creek has a more spacious valley for three miles above its mouth.

In this distance the walls on the left side going up are several hundred feet in height, and in thick beds of argillaceous quartzose and mica slate and calcareous formations. Above this, for about one mile, the wall is mainly covered by talus and surface deposits, but on the opposite (right) side is a perpendicular wall of over 1,000 feet, and reaching up to near timber-line, and of an entirely different character. The lower beds, or those within reach, are of a dark maroon, hard, compact limestone, with beds of conglomerate of like character, and rounded pebbles. These beds alternate with thin plates of micaceous sandstone of like color, which weather out on their edges and give to the escarpment the appearance of masonry constructed after the strictest rules of architectural proportions. This exposure is seen only for about one mile, when a cascade in the stream, a dip in the formation, and deundations above the falls hide it from view on this side of the valley above the cascade, but on the opposite side (above the falls) it occurs in a cliff of several hundred feet in height. This, too, soon disappears by the rapid ascent of the valley, and trap and volcanic deposits take its place.

These red formations are, too, of a modern date, formed since the valley had assumed its present proportions, and which they once filled. Such conditions are not easily conceived from the present standpoint, especially as a branch valley was also filled, but with different material.

Further comments on this subject will be made in the *résumé.*

In passing from the mouth of the valley of Mineral Creek to the left along the north boundary of Hamilton Park, the quartzose formation, previously noted, is replaced by feldstone trap, and this again by mottled granite in a small ledge at the mouth of the cañon of Cement Creek.

This granite exists in regular beds, is easily quarried, and would make a good and durable building-stone.

Cement Creek differs but little from the north branch of Mineral Creek, and was also once filled with modern formations after the valley had been formed. Seven mineral veins have been found, mostly galena. Two on Matilda Creek, a branch of Cement Creek, and one still higher up the main valley, contain silver. Rich float-specimens were found, whose veins are probably located well up toward the summit.

Further prospecting will probably develop this valley and its surroundings into a rich mineral field.

Little Giant Gulch is situated on the left side of Las Animas River, and is a mere *cul-de sac* of a few miles in length, closed in on three sides by high mountain ranges. On the right side near timber-line is situated Little Giant gold-mine. The lead is 2½ feet in width, the walls are of compact feldstone and the gangue quartz, copper, and iron pyrites. A drift of 60 feet and its developments prove this to be a true lode.

No large amount of the ores had been reduced, but the company had erected at a heavy expense a mill, which was not yet in operation. I had no means at my control to test fully the value of this ore, but the proprietors entertain reasonable expectations of a large return.

There are several other leads in this gulch. One or two have some of the characteristics of the Little Giant vein, while others are mostly galena, and still others galena and silver. Though in none had the developments reached beyond the prospect-pit, they thus far promised well.

At or near the summit of one of the ranges is also a vein of pure galena 100 feet in width. I did not visit this locality, in consequence of the hazardous ascent, but the fact is so well attested that I gave it full credence.

The walls of the Little Giant Gulch are mostly feldstone. Cunningham's Gulch is a narrow valley that connects with the left side of Baker's Park three miles above Little Giant Gulch. Its walls are composed of porphyry, mica slate, and quartzite rocks, and the summit volcanic trachytes.

There are several veins of galena, supposed to contain a large percentage of silver. This is propably true in reference to the Mountaineer and Green Mountain leads, but I have no definite data to that effect. There are numerous other leads that may be equally promising, but the claimants were absent, and but little knowledge could be obtained respecting them, and the prospect pits were in a dilapidated condition.

Eureka Gulch, situated near the head of Baker's Park, is a narrow gorge on the right of the valley. Its walls are mostly trap, overlaid by volcanic deposits. No mineral leads have been discovered here, not for the want of favorable indications, but because several years since a large amount of labor was expended in washing for gold, and, the enterprise proving unprofitable, was abandoned.

Baker's Park is a mere widening of the Las Animas Valley about eight miles long and a half a mile broad at the widest place. Its walls are mostly of granular and crystalline feldstone.

This is traversed by innumerable veins of quartz, some reaching from the base of the valley to near the highest mountain peaks. This is peculiarly so in Galena Mountain, where a rich vein of ore exists above timber-line, and is only lost by being covered with volcanic deposits.

The veins of quartz do not all contain mineral nor a tithe of them; but many rich leads of galena have been discovered, and some of them contain more or less silver. It is but reasonable to suppose that when the field has been fully developed it will be found second to none other in the precious ores. This remark will apply to all the upper portion of the district.

With the exception of one or two instances, the development of the veins have only extended to shallow prospect-pits, and no definite opinion could be rendered of their value or permanency; but I can only repeat that in a region so prolific in minerals true and rich lodes exist, and if the ores representing the leads in the succeeding list were assayed, the pertinence of this observation would become apparent.

However, the remoteness of this district from supplies and the absence of good roads will be an adverse element in its prosperity until Animas Park, forty miles below, shall be thrown open for settlement.

That beautiful country commands all the natural elements for a prosperous agricultural region, where the mines might be supplied.

I might, if space would permit, extend these remarks to the anthracite-coal region and iron-ores near by, (all within reach of this mining district,) where the needful implements might be forged.

*A list of veins and mines from which gold, silver, and galena ores were collected on the Ute reconnaissance, by F. Hawn, geologist of the expedition.*

| No. | Name. | Locality. |
|---|---|---|
| 1. | Black Swan | Cement Creek. |
| 2. | Monarch | Cement Creek. |
| 3. | June-Bug | Cement Creek. |
| 4. | Little Giant | Little Giant Gulch. |
| 5. | Aspen | Little Giant Gulch. |
| 6. | Green Mountain | Cunningham's Gulch. |
| 7. | Saint Louis | Cement Creek. |
| 8. | Missouri | Cement Creek. |
| 9. | Monitor | Little Giant Gulch. |
| 10. | Leavenworth | Baker's Park. |
| 11. | Mountaineer | Cunningham's Gulch. |
| 12. | Royal Charter | King Solomon Mountain. |
| 13. | Royal Charter | King Solomon Mountain. |
| 14. | Eureka | Baker's Park. |
| 15. | Saint Lawrence | Galena Mountain. |
| 16. | Robert Burns | Las Animas District. |
| 17. | Gadsen | Baker's Park. |
| 18. | Water-Fall | Baker's Park. |
| 19. | | Baker's Park. |
| 20. | Tom Moore | Las Animas District. |
| 21. | Colorado | Las Animas District. |
| 22. | Bobtail | Cunningham's Gulch. |
| 23. | Mary Ann | Cunningham's Gulch. |
| 24. | John Butler | Baker's Park. |
| 25. | McKe | Baker's Park. |
| 26. | Wyandotte | Las Animas District. |
| 27. | Union | Las Animas District. |
| 28. | John | Las Animas District. |
| 29. | Bay State | Cunningham's Gulch. |
| 30. | Chicago | Las Animas District. |
| 31. | Ohio | Baker's Park. |
| 32. | Lady Elgin | Little Giant Gulch. |
| 33. | Andrew Jackson | Baker's Park. |

| No. | Name. | Locality. |
|---|---|---|
| 34. | Senator | West Mountains. |
| 35. | Union Cap | Las Animas District. |
| 36. | Mountain Boy | Baker's Park. |
| 37. | Scotland | Lake District. |

### *Geological observations from the mouth of Lake Mary Cañon, via Lake Fork of the Grand River, to Del Norte.*

At the south end of Lake Mary Cañon is a heavy formation of soft gray and blue shale, in horizontal strata. The west wall of the cañon is of red porphyry, which is mostly covered with coarse conglomerate, often in walls 800 feet in height. The east wall constitutes the west flank of Bristol Head, and is wholly of igneous origin.

High up on this wall, coinciding nearly with upper timber-line, are remnants of white and colored clays, formations of which once nearly filled this cañon, and this, too, previous to the conglomerates, as at several localities I found the former combined with the latter. The trail to the Clear Creek Falls was mostly over porphyry and trachytes; thence the valley of Clear Creek was undulating, with but few outcrops, to near the close of the march.

Immediately east of Camp 43 is a high ridge of loose, disintegrating brown trachyte, of the character observed on yesterday lower down in the valley. But few outcrops to the summit of the pass to the Lake Fork, elevated (ascertained by one observation) 11,356 feet.* The summit and the heads of valleys on the north comprise a beautiful undulating surface, as far as the eye can reach, embracing thousands of acres of rich soil, indicating an active growth of vegetation in some seasons of the year.

On descending into the valley of the Lake Fork of the Grand River, white and yellow clays were encountered, similar to those of Lake Mary Cañon. The bright colors of these clays are visible far down the valley, often coinciding with timber-line. The older formations are of slate and quartzose porphyry. The wall-rock of the San Cristobal Falls is of trachyte, which had partially filled a portion of the valley, and is disintegrating at some localities, and resembles that observed near Camp 43. At an elevation of about 500 feet above the falls, on the right side of the stream, is what is claimed as a vein of galena rich in silver. It had been but partially opened, and the claimants not being present, little or no information could be obtained. I could discover no indications of a regular or true lode.

Quartzose and porphyry seemed to be the prevailing formations on the lower side, and, a short distance above, slate. I gathered a few specimens of the ore, which are represented by No. 37 in the collection.

A solitary cotton-wood at Camp 45 is the only specimen found by me at so great an altitude. Below Camp 45 are few outcrops, principally red trachyte porphyry. The mountain-sides are stained with red and white clays to near upper timber-line.

There were but few outcrops for seven miles below Camp 46, excepting a few fragments of conglomerates. At the end of this distance we passed through Great Gate, a narrow gorge of about three furlongs in length, with walls of trap. Thence down to Lake Fork Cañon, the lower slope of the valley is mostly of red trachyte porphyry. Near Camp 47 is a dike of feldspathic trap.

The high ground flanking the cañon on the west is composed of feldspathic granite, including a bed of rose quartz twelve feet thick. The lower portion of the cañon is traversed with numerous quartz-veins, but none were discovered bearing valuable minerals.

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* This elevation may be considerably wrong, as the United States Signal-Service reported a terrific storm to have occurred to northwest and west of the Mississippi River on the night of this day.

On leaving the Lake Fork and ascending the right slope of the valley, I observed the red trachyte porphyry of the preceding march, overlaid by gray trachyte. I observed an oak, *Quercus ganayana*, at an elevation of 7,970 feet.

From Camp 48 the surface is regular, with outcrops of quartzose rocks, and hills are bespangled with mica. Near Camp 49 were formations of porphyry, gneiss, volcanic tufa, trachyte, iron-ore, pitch-stone, nepheline-dolerite, mica, trachy-dolerite, greenstone trap, and hornblende rock. Below Camp 49 are quartzose rocks on the elevations, and brown trachyte on the slopes. Three miles to the right of Camp 50 is a deep cañon, with walls of trachyte like that observed near the summit of Clear Creek Pass.

In front of Camp 51 is a high ledge of brown trachyte like that recorded as seen in the cañon near the last camp.

The bluffs on the right side of Tumitchi Valley are capped with red porphyry, and along the Ute trail leading to the pass are frequent outcrops of white and yellow stratified clays in horizontal position. These formations seem to be like those found in Lake Mary Cañon and in the valley of the Lake Fork of Grand River; in fact, in nearly every principal valley that came under my notice.

Tumitchi Valley is broad and fertile, and affords grazing for several thousand head of horses and cattle, sheep, and goats of the Utes.

After leaving the valley, the ascent toward the pass is uniform, the soil dry, and grazing indifferent.

In the vicinity of Camp 52 is an outcrop of gray granite. The contour of the surface is comparatively regular to near the summit of the pass, with but few exposures. The elevation of the summit deduced from one observation was 9,834 feet. From the summit down on the Atlantic slope to the Saguache Valley the surface is precipitous and broken, the effects of a deluge of volcanic trachyte.

This deposit seems to be identical with that observed near the summit of Clear Creek Pass, in the cañon near Camp 50, and in the ledge near Camp 51.

The volcano that emitted these deposits must have been one of great force and in active operation after the surface had nearly attained its present form.

During most of the march down the valley of the Saguache the slopes were composed of trachytes. Fragments of white clay like those noticed in the Tumitchi Valley were frequently observed at high elevations.

On the left side of this valley opposite the upper end of the cutoff road is a formation of coarse gray sandstone of recent date, occupying 60 feet of the lower slope of the mountains.

As the valley widens and gradually merges into the San Luis Valley, the walls on the west side are wholly of igneous origin.

Near Camp 55, the valley is several miles in width, and a small portion of it is under cultivation, aided by irrigation. The yield of wheat is probably seven or eight bushels per acre, and is of a superior quality. Oats, barley, and potatoes yield large returns, and are of unrivaled excellence. Grazing is also good.

Four miles below Camp 55 we enter San Luis Park, and the march then continued along the west margin. A few points of the mountain-slopes approached near enough for examination, and were found to be of porphyry and trachyte. We continued our march along the margin of the San Luis Park, and connected with the line of our outward march at Del Norte.

### *Geological observations on Ute reconnaissance from Fisch's Ranch to Pueblo via Cochetopa Pass, head of Gunnison's River, and Lake Creek Pass.*

As the several lines of observations have nearly encircled a part of the San Luis Valley, it may not be irrelevant to enter here a more detailed description of this portion of that extensive inclosure.

That part of the valley north of a due west line from Fort Garland is a treeless plain, descending toward the south side, with the Rio Grande on the west.

That portion under consideration includes an area of about 700 square miles, with a mean elevation of 8,500 feet.

The central portion receives the drainage of the mountain-ranges on the north and northeast into a lake without an outlet. The extent of the waters of this lake varies with the season, increases with the melting of the snows, and equilibrium is maintained by evaporation.

In the vicinity of the lake, and so far as its waters impart moisture to the low and changing margin, vegetation is fresh and exuberant, resembling an oasis in a desert. The lake, with these conditions, comprises about one-tenth of the area under review. The remaining portion is arid, the surface more often monopolized by *artemisia* and *cacti*.

As a cattle-range it is not to be recommended. True, herds are fed the year round on the scanty bunch-grass as nature provides and cures it, but my observations tend to the conclusion that there can be no practical development in cattle reared under such circumstances.

Sheep, however, thrive, are healthy, increase rapidly, and are comparatively free from disease.

The valley, or approach to the Cochetopa Pass from the Atlantic side, is principally red porphyry.

At Camp No. 7, elevated 8,100 feet, is a fragment of a ledge of conglomerate which I traced 360 feet upon the mountain-slope; still 50 feet above the latter point is a formation (*in situ*) of soft, gray mottled limestone resting on a hard brown limestone. These formations are 50 feet thick, in horizontal strata, resting against porphyry.

The rocks farther up on the slope are of a brown trachyte, and the face of the ledge is much water-worn. The lines are fresh, as if the water had but recently receded.

Soon after leaving Camp 7, the surface-deposits conceal the more solid formations.

After descending the Pacific slope about 400 feet, fragments of white limestone were observed, and lower down in the valley, in regular strata, at intervals, as low as our encampment.

Mr. Prout notes "that between Camps 8 and 9 the route lies over a mesa of sandstone underlaid by granite, which crops out here and there. There is very little soil, consisting mainly of decomposed granite and sandstone. Near Camp 9 the Tumitchi flows, in a cañon 100 to 300 feet deep; much rock exposed—dark gray sandstone.(?) About two miles above this point the cañon is deeper, with walls of red feldspathic granite."

The foot-hills, down to near the junction of Pass Creek and Tumitchi Creek, are of gray shale and white calcareous slate, similar to the gray mottled limestone mentioned between Camps 6 and 7.

At the junction of the creeks named is a prominent point of coarse conglomerate, and a little lower down the stream a ledge of volcanic trachyte. One mile below this occurs a ledge of feldspathic granite 50 feet thick, succeeded by 150 feet of quartzose strata, granular at the base and shading upward into a quartzose sandstone of different colors, this again succeeded by red porphyry 80 feet thick and capped by trachy-dolerite.

The two latter are much like those formations in the eastern approach to the pass, and the trachyte identical with that vast volcanic deposit on the Atlantic slope, along the Ute trail, between Camps 52 and 53. Farther down Tumitchi Creek the granite forms the walls of a cañon, is 150 feet thick, is often quartzose, in several instances penetrated by trap dikes.

Between Camps 9 and 10 the granite disappears. The sandstone and trachyte were observed to the close of the day's march.

In the bluffs on the right, on entering Cochetopa Valley, is a ledge of hornblende slate. From Camp 10 the slopes on the right side are of the quartzose sandstone observed in Tumitchi Valley. On the left are frequent protrusions of trappean deposits. Coarse conglomerates also occur at intervals.

From Camp 11, except in the distance, the mountains dwindle into foot-hills, regular in contour, with a few outcrops of quartzose, sandstone, and protusions of trap in the earlier part of the march.

At the base of the former occur 25 feet of fine conglomerate of small silicious gravel and rounded water-worn pebbles.

These were cemented by a white paste and formed one solid mass. The finest would take a fine polish and might be worked into ornaments

These were probably the result of the earliest fluviatile development.

In the same vicinity, but lower down in the valley, is another species of conglomerate in high ledges, coarse and of recent date.

Four miles above the head of Gunnison River they form escarpments several hundred feet in height.

During the greater part of the day a distinct shore or water line was observed on the left of the stream, 800 feet above the bottom of the valleys.

Three miles above Camp 12, on the right of Ohio Creek, elevated 7,647 feet, I found a bank of marly shale, in thin and horizontal laminal, containing *Ostrea congesta*, and many fragments of what was once a large and fragile *Inoceramus*.

The formation is 75 feet thick and outcrops were frequently observed during the day higher up along the valley. This is one of the earlier formations of the cretacious system, and is the equivalent of No. 3, of Meek and Hayden's Nebraska sections, 1857.

Thick beds of coarse conglomerates were frequently observed above this formation.

Immediately above Camp 13, is a high table with terraces of light brown, hard, compact, amorphous sandstone, dipping toward the southwest. It lays against Mount Umbraculum, and reaches high up in the approach to the pass leading across to the head of Nigger Creek and Anthracite Creek.

Mount Umbraculum, a spur, is of volcanic origin, mostly a porphyritic trachyte.

The herbage luxuriant, rich, and abundant. Not that the soil is any different from that of the valleys below, but here the surface receives the diurnal rains that prevail in the mountains from July to September, but rarely reach half a mile below lower timber-line.

Yesterday I observed the full effects of these conditions. In traveling up the valley of Ohio Creek and approaching Mount Umbraculum, in one mile I passed from arid sterility to fertility and exuberance in vegetation that equaled the far-famed prairies of Illinois. This close relation between timber and the rains is a rule without an exception so far as my observations have extended.

Soon after leaving Camp 14, at an elevation of 9,280 feet, observed a thick formation of a sandstone conglomerate. This, with extensive beds of sandstone like that of yesterday, occur during the march.

At the head of Anthracite Creek, at an elevation of 9,100 feet, I observed the following section in descending order:

No. 1, 75 feet hard, compact, light-brown sandstone, in thick, irregular beds.

No. 2, 4½ feet anthracite coal; in luster and fracture resembles the Lehigh coal.

No. 3, 90 feet black slate and black shale, interstratified with sandy shale.

No. 4, creek bottom.

This section dips down the stream, and soon disappears beneath the valley.

The want of time precluded me from making an estimate of the extent of this formation, as this depends on contingencies somewhat intricate.

The base of the mountain is composed of syenite, the higher portion of feldstone, trachyte, and volcanic tufa.

On going down Nigger Creek, we found the mountains the same as on Anthracite Creek.

Ledges of brown sandstone were observed at several localities, and fragments of black slate in the creeks.

Washington Gulch is an old place, situated on a small stream of the same name, 300 feet below upper timber-line. A large amount of work was done here in washing for gold, but for the want of remunerative returns the mines have been abandoned.

The bed-rock is of a hard blue slate, that disintegrates into small cuboidal fragments. I traced this slate, alternating with dark-brown indurated clay, for six miles down the gulch to its mouth, at the foot of Lone Mountain, opposite Nigger Gulch, where I found two casts of fossils, resembling *Inoceramus*, but too imperfect for identification.

These formations are in horizontal strata, and their aggregate thickness amounts to several thousand feet.

Lone Mountain is composed of gray granite; but the high peaks at the head of Washington Gulch are of volcanic origin.

At several points on the march down Slate River, a tributary of Taylor River, I observed the blue slate formation of the preceding march, especially opposite East River.

The lower slopes of the mountains are mostly covered with surface-deposits.

In the mouth of the valley of East River is a ledge of calcareous tufa. Higher up on the slope, the formations are of a quartzose character. One mile above the mouth of the valley and sixty feet above the base, is a high ledge of irregular stratified limestone, seventy-five feet in height, somewhat changed by heat.

Found no organic remains except a small incurved shell not identified. This ledge is but a fragment, and lays over red felspathic granite, which has incorporated with it irregular masses of gneiss. A short distance above this, granite forms the side walls of a deep and narrow cañon about five furlongs in length. Above the cañon, limestone and shales appear to constitute the right slope of the valley, with occasional remains of conglomerate. About four miles above the cañon and above where the trail ascends the left slope for Deadman's Gulch, the walls of the valley are of thick, brick-red, arenaceous beds in horizontal strata, reaching up nearly one thousand feet above the bottom of the valley. This formation is distinct from the shales and limestone found below, and is probably more recent, and resembles a like formation on the west branch of Mineral Creek in Las Animas Valley, and also in Animas Park.

In the vicinity of Camp 20 occur heavy beds of conglomerate composed of angular fragments of gray limestone of like quality as that found on the right slope of the valley of East River above the cañon.

The high peaks between Deadman's Gulch and East River are of volcanic trachytes.

On descending Deadman's Gulch, outcrops of gray and brown sandstone and black slate are of frequent occurrence. At the point where the trail leaves the gulch a high bluff in covered with blue slate with a stratum of blue slaty limestone at the base in horizontal position.

One mile above the mouth of Spring Creek, (which the trail ascends,) on the left side, 120 feet above the bottom, is a ledge of gray, brown, and blue granular and crystalline limestone, 65 feet in height and seemingly destitute of organic remains. This formation flanks the valley for a short distance and then dips beneath it. A short distance farther up the stream, on the right side, is a slide of 200 feet, exposing coarse brown sandy shale, sandstone, and bituminous shale, in which occur *Fusylina cylindrica*, *Spirips lineatus*, and *Spirigera*, *Muoonensis*, well-marked coal-measure species. Still farther up the stream, the limestone last referred to, with 135 feet of sandy shale and sandstone above it, is seen where the trail leaves the valley.

Immediately after leaving the valley of Spring Creek, there occurred an extensive slope of loose fragments of grayish-brown trachyte. A few hundred yards farther, the mountain-slope is lined, to the height of 250 feet, with hard, compact blue limestone much altered by heat. This formation rests against a porphyritic trachyte, and, where well exposed, it is seen in ranges of large cuboidal blocks. For strength and durability this rock could not well be surpassed.

For the remainder of the day's march, including 5 miles, much of the surface and foot-hills have forms indicating conditions of Spring Creek Valley.

Between Camps 21 and 22 the lower slope of the mountain is composed of gray hornblendic granite.

I visited the gold-mines 14 miles south of Camp 22. The trail leads down Taylor River for 11 miles when that stream enters a formidable cañon on the right. The trail then crosses the foot-hills over into a circular park 4 miles in diameter, drained by Willow Creek, that passes through a narrow cañon into Taylor River. The placers were known as the Cotton, Grass-root, and Union Gulches. The first is exhausted; the second abandoned, and the last is now but feebly worked. Formerly this latter gulch yielded large returns, but now it seems to have become nearly exhausted.

The valley of Taylor River from Camp 22 to the cañon is from one to three miles in width. The low bottoms are boggy and afford fresh coarse grass. The high grounds are dry with a thick growth of artemisia and cacti. The valley proper and the two tributaries coming in from the left afford a large scope of good grazing. The park too, in which the gold-mines are situated, has some excellent pastural facilities.

The slopes of the mountains are covered with dense growth of spruce-pine, aspen, and fir.

In approaching Lake Creek Pass from the Pacific side we pass for three miles over dunes composed of rounded fragments and boulders of such rocks as are found in the range of mountains fronting us. From the entrance of the gorge to the summit, a distance of 4 miles, the walls are composed of nearly white hornblende granite. For strength, beauty, and durability, this rock is unsurpassed. The walls on the left of the summit are of red granite and the high peaks of volcanic dolerite. The summit (from an observation) is approximately 11,743 feet above the gulf. Immediately on descending the Atlantic side the granite becomes micaceous with irregular beds and mass of mica, slate, and gneiss. The hornblende seems to have segregated into large rhombic crystals, that on a weathered surface stand in relief and impart to the mass the appearance of conglomerates. One mile below Camp 23 occurs a bed of trachyte porphyry, coinciding with the bed of the creek, but the mountain slopes are of granite with large masses of gneiss. In the latter portion of the day's march the granite becomes less micaceous, but more quartzose. Large rectangular masses of this mineral are often observed in the face of the ledges.

From the mouth of the cañon to the foot of Twin Lakes, a distance of about six miles, the valley bottom spreads out into an area of about fifteen square miles, of which the lakes occupy about three-fourths. The slope of the valley on the left is a series of dunes and undulating ridges rising one above another until they are lost in the mountain slopes far in the rear. These ridges are often so uniform as to suggest ancient shore lines. The surface is strewn with water-worn debris of rocks whose parent ledges may be found in the mountains of the vicinity. On the right side the mountain slopes come down abruptly to the base of the valley.

One mile below Camp 25, on the outlet of the lakes, commences a series of gold-washings. These, with others of more note on the Arkansas River a few miles below, and many lateral gulches, form a mining district of considerable extent. Gold was first discovered here in 1860, and a large amount of work has since been done. Formerly some of these gulches produced well and were remunerative, but now most of them are abandoned. About fifty men are now engaged.

The mountain slopes are of micaceous granite and craggy below Granite City.

One mile below Camp 26 the valley commences widening out, and in two miles more becomes an undulating plain from two to three miles broad, descending from right to left, with the river running close to the foot-hills. The soil is gravelly and dry, but where irrigated it produces good crops of barley, oats, wheat, and fine potatoes, as the productions of several farms passed prove. The lower slopes of the valley are of disintegrating micaceous granite.

The mountains on the left, for twelve miles below Camp 27, are of micaceous granite, then red porphyry to the end of the day's march. On the right white and brown clays reach 400 and 500 feet up on the mountain slopes.

Near Camp 28, at the bottom of the valley, is a formation of soft, porous, chalky limestone, 15 feet thick; no organic remains found.

Four miles above Camp 28 the valley is partially closed by a transverse ridge, which is cut by a cañon that once discharged the waters of the Arkansas River, but is now dry and elevated 60 feet above the stream.

Passed several farms where harvesting of oats and barley was in progress. The crops seemed immature, but in other respects were good. Shocks of wheat were standing in the field. The straw of these crops was short, the grain remarkably plump and firm, and the best fields would yield about ten bushels per acre.

On the right side of the valley the mountain slope is covered with white and yellow clay. On the left, a few miles below Camp 28, the formations change to those of volcanic rocks, including trachyte, dolerite, and hornblendic rocks. The broad valley, for the last three days, terminates at the junction of the south fork of the Arkansas River.

One mile below Camp 28 is a vein of carbonate and oxide of copper in quartzitic slate. No evidence that it is a true lode. Immediately below this is a ledge of gray cherty limestone, three hundred feet in height, much changed by heat. No organic remains found except small fragments of *Cynthophyllum*. This ledge dips rapidly down stream and soon disappears beneath the valley. This is succeeded by hard ferruginous gray and blue sandstone in thick ledges, dipping at an angle of forty-five degrees with the direction of the stream, to Camp 29, a distance of three miles, developing a bulk of many thousand feet.

Soon after leaving Camp 30 the sandstone of yesterday began to thin out and, on reaching Pleasant Valley, a distance of two hundred and fifty miles, it existed only in fragment ledges on the slopes of the mountains. Volcanic productions assumed the place of sandstone, and in large deposits of coarse, reddish-brown, trachy dolerite.

The lower portions of the valley, the slopes, are a red micaceous granite with masses of gneiss. The valley averages about one and a half miles in width and seven hundred and fifty long, a portion of which may be irrigated.

Passed several farms with a portion of their crops in the field. The wheat a fine berry and will yield ten bushels per acre.

Pleasant Valley terminates in three formidable cañons. Through the first and largest flows the Arkansas River. Through the next, on the right, the Arkansas receives Spring Creek. One furlong further down the stream, and also on the right, is a dry cañon. These united exhibit an amount of erosion rarely seen in so small a compass. The walls are of red granite with irregular beds of gneiss.

Immediately after leaving Pleasant Valley, the road leads among the foot-hills up to the high table-land. On the right of the river, conglomerate white clays, mixed with gravel and chalky limestone, were observed as high up as eight hundred feet above the valley; wherever we descended below that level, during the day, there were indications of these formations.

Our march to-day was over high and undulating table-lands, as the Arkansas River is reported to flow through a continuous cañon, from Pleasant Valley to Cañon City. In the vicinity of Camp 32 is a ledge of rocks from which I obtained specimens containing diorite and epidote, quartzite, and epidote and feldstone. The trail, like yesterday, passed over high table-lands.

Visited the iron-ore beds on Pine Creek, a branch of Grape Creek, a southern confluent of the Arkansas River. Saw none of the ore in the natural bed, but several low round mounds were covered with rich specimens. These mounds occur at intervals for two miles or more. The ore is associated with dolerite, the mountain in the vicinity seemed volcanic and of this mineral. The walls of the cañon in which we were encamped are of granite with irregular masses of gneiss.

Two miles below Camp 33 we enter a valley six miles long and three miles broad, in which are ledges of brown and yellow sandstone dipping toward the southwest. Lower down in the valley are also white and other light-colored clays, white compact sandstone, and soft crumbling chalky limestone. The formations are nearly in horizontal position.

The mountain-slopes are of red granite, with veins and clusters of gneiss and rose quartz. At the foot of this valley the walls of both sides of the cañon are broken away, through which the river is approached and crossed.

We again leave the Arkansas River and ascend to the table-lands through a dry cañon. This elevated region differs in none of the essentials of those over which we passed since we left Pleasant Valley.

On descending again later in the day we met heavy formations of limestone dipping at nearly every angle and crowning some of the high foot-hills. These strata are hard, cherty, massive, and compact. They soon disappear with a general dip toward the east. We then pass on to thick beds of conglomerate ferruginous oxides, cementing rounded pebbles and water-worn boulders. These are extensive, in nearly horizontal position, and were the result of forces in operation after the limestone was in position and the valley had been exoded.

Still farther down the valley there occurs thick beds of silicious sandstone and shales, which form prominent features in the left side of the valley to the opening of the plain on the east.

At the mouth of the cañon from which the town takes its name is a thermal spring, with a temperature of 114° F, but its discharge is too limited to be of any great practical benefit, whatever its medicinal properties may be. Within the lower limits is a mineral spring issuing out from under the sandstone. It is also weak in flow but discharges a large amount of gas.

Judging from its taste and the effects on the system, the alkalies are in excess and are consequently not of much medicinal value.

A mound on the prison grounds at Cañon City is composed of light gray, shaly limestone, with *inoceramus problematicus* with two other species and the remains of fishes. These strata stand upon their edges, whether the result of a slide or from some internal convulsions could not be definitely determined.

In passing down the valley on the right side of the Arkansas River, ledges of heavy-bedded brown sandstone constitute the bluff of the stream for nine miles. These are nearly horizontal in position, and seemingly had never been disturbed, but break or cease suddenly, and the cretaceous limestone comes in with a bed of coal 550 feet thick.

I have no evidence to present that this coal belongs to the Cretaceous age. Organic remains of that system are found five feet below the coal bed.

The coal is hard, brittle, and lustrous, reflecting the rainbow hues. It contains a large amount of gas, burns free with a clear blaze, but has too small an amount of fixed carbon to produce an intense heat.

The Colorado Central Improvement Company are the proprietors of these coal-mines, have built a branch road to them, and are shipping.

At Cañon City we realize that we are approaching the great plains on the east. Here the valley widens out to an extensive undulating prairie, which is effectually protected on the north by a range of mountains extending east from Cañon City to Pike's Peak, where it intersects the range flanking the eastern plains.

Several productive farms are cultivated below Cañon City and are irrigated by the water taken from the river.

*Résumé.*—The economical branch of the reconnaissance was elaborately represented in my journalized report, and therefore needs no reviewing, but that portion of your instructions relating to incidentals were recorded mainly in specific facts; a further illustration of their correlations may not be irrelevant.

On the 8th of May we started from Pueblo, and before the close of the day came upon limestone of the Cretaceous age. On the three succeeding days, I traced their contiguous formations to near the mouth of the Huerfano Cañon, and classified them into a section. I traced the equivalents of these formations from the mouth of the cañon at Cañon City, down the Arkansas River to Pueblo. Here we have over one hundred miles of very interesting rocks as familiar to me as my own door-yard; having traced them for many miles in Kansas, on a survey of that State. After crossing the Eastern Range, we came into the San Luis Valley. On the very margin, I observed indications that this broad and extensive valley had once been a lake. Along the several lines these indications multiplied into relative facts.

Above Wagon-Wheel Gap we entered a broad valley in which I reported the existence of yellow clay and clay slate of considerable thickness. Next day these were noted in formidable thickness lying against the slope of the mountain.

Above Antelope Cañon are remnants of clay and conglomerate formations reaching nearly up to timber-line, and once filling this portion of the valley.

At lower levels the walls shows the mark of fluviatile action as plainly as if the waters had just receded. These and like phenomena exist in nearly every valley, pointing to forces and conditions that have long since ceased. The volcanic action may be remarked upon as follows: At the exit of the Rio Grande from the mountains, basalt intrusions from below occur, at Camp Loma, volcanic flux from above. Each volcanic center has left its own peculiar deposits; these may readily be distinguished one from another. The frequent change in these elements along our lines, leads me to the opinion that the centers were numerous and limited in extent. Except, perhaps, in one instance, on the Ute trail over the Central Range, the slope of the Saguache Valley has been deluged with volcanic flux from near the summit to the base; that, too, comparatively recently, since the valley was formed.

This volcanic matter I traced to the Cochetopa Valley, where I found it under peculiar circumstances alike novel and instructive, if I should give scope to my imagination. I might locate the center between Cochetopa and Clear Creek Passes.

In a comparative view of the structural relations of the different mountain ranges, the igneous productions are far more predominant than the granitic classes. This remark will apply more particularly to the Pacific slope, where but in one instance a large scope of granite was observed.

We crossed this granite field in five miles—on the high grounds west of Lake Fork, ten miles above Gunnison River, and again on a parallel line in Tumitchi Valley, where it is exposed in ledges of 150 feet. Admitting that the formations of the two valleys coalesce, or are contiguous, it would only make an insignificant area of about 75 square miles.

But immediately after crossing Lake Creek Pass, and attaining the Atlantic slope and the waters of the Arkansas River, granite is the prevailing rock.

On the Pacific slope, too, I found more definite indications among the older rocks of the reconstruction of their disintegrated matters into more definite forms.

In the valley of Tumichi Creek occurs a stratified quartzose formation of 500 feet in thickness, granular at the base, and gradually shading up into a siliceous sandstone of various colors. This formation was observed in the valleys below as far as Taylor River. The igneous rocks are divided between the trappean and the volcanic deposits; the former more often occupies the lower slopes, while the latter often overlaps the former, and occupies the high peaks.

Some of the volcanoes were in active operation long after the other deposits had become consolidated.

On the Ute trail, over the Central Range, the slope of the Saguache Valley was deluged with volcanic flux from near the summit to the base. Fragments of beds of this flux were found in depressions of Cochetopa Valley, indicating it to have been of recent origin, or since the surface had assumed its present form. The thickest beds, however, are found in the Central Range, toward the west, and probably in the direction of the center of dispersion. There are other formations more definite in their characteristics, more recent, and limited to the valleys, but, nevertheless, intricate in their positions.

Between Hamilton and Animas Parks, the right slope of the valley of Las Animas and mountain is covered in large areas by carboniferous formations of the Coal-Measure period. These were classified into a section by Assistant L. Hawn, and embrace over one thousand feet in the aggregate. At the head of Anthracite Creek occurs a bed of anthracite coal in connection with and in the vicinity of thick and massive formations of sandstone, shale, and conglomerates, at an elevation of about nine thousand feet above the Gulf of California. These, like those formations in Las Animas Valley, dip at considerable angles. A preponderance of coal-measure formations exist also along the line of march of the 13th of September, between Camps 21 and 22.

I might also refer to the lesser formations of this period, on the Atlantic slope, in the valley of Sangre de Cristo, but they are fully explained in my journal.

The relative position of these carboniferous formations is readily defined, when it is known that the mountains were forced up into their position at the close of the Carboniferous age, and in many cases carried up with them fragments of that system. The other, or more recent formations, to which reference has been made, are not so easily defined or comprehended. In illustrating, I will endeavor to read the history of the mutations of a park through which Cochetopa Creek, Taylor River, and Ohio Creek run, and their junction at the lower end of the park form Gunnison River. The original condition of the park, with the valleys, were probably mere clefts in the mountain, but the manipulating forces of the elements during five successive ages, including millions of cycles, wore away and formed the outlines much as we now find them. Early in the fifth age and the second condition of the park, it became an estuary of the sea, as the marine deposits prove. The remnants of these deposits were found on the right side of Ohio Creek, three miles above its mouth, consisting of marly clay and slate of the same. The thickest measures about 90 feet, but the indications are that the formation will reach 200 feet, and an altitude of 7,600 feet above the Gulf of California. In the several outcrops I found *Ostea congesta*, and numerous fragments of a fragile inoceramus. These are referable to the earlier productions of the Cretaceous age, and the undoubted equivalent of No. 4 of Messrs. Meek and Hayden's Nebraska section of 1857. It is the next formation in the series above the section classified during the reconnaissances, the formations of which extend in the valley of the Arkansas from Cañon City to Pueblo, thence along the base of the mountains to Huerfano Cañon.

These two formations (Nos. 3 and 4 of Meek and Hayden's sections) are also prominent along the Republican Fork in Kansas, between the 97th and 99th meridians. There seems to have been a coincidence in the level of the ancient cretaceous ocean on the west and east sides of the mountains, as I found a fragment of No. 3 on the slope of the mountains above Boulder City, at about the same elevation as No. 4 on Ohio Creek.

This closes the second condition of the park. To understand the third, it becomes necessary to retrace the line of march back to the junction of Tomitchi and Pass Creek, at an elevation of 8,200 feet, or 600 feet above the cretaceous formation in the valley below. Here we find a white, porous, impure limestone, in irregular strata. This formation is succeeded by others mostly of ashy-gray clay, shales, and soft slates, until it reaches nearly the level of Cochetopa Pass, or an altitude of over 9,000 feet. These formations seem to be destitute of organic remains, but from their lithological characters would consider them of fresh-water origin, and once filled these valleys and closed the third condition of the park. Subsequently the valleys were reopened, and during the process thick beds of conglomerates were formed, fragment ledges of which may be found along the valleys and in the park by the side of, and overlaying, the cretaceous deposits in escarpments of several hundred feet thick. This constituted the fourth period in the the history of the park. With the exception of the cretaceous formation, the history of this park and its valleys is the history of nearly every valley that came under my observation. Exceptions may apply to the valley of Slate River, that was once filled up to near upper timber-line with blue slate, including a range in height of several thousand feet. In this formation I found two worn casts of what once might have been *Inoceramus*. Also Mineral Creek of Las Animas Valley; on the west branch of that stream exists a fine, compact dark maroon limestone, in thick and regular beds, one thousand feet thick and reaching up to near timber-line, or an elevation of 11,000 feet. The main valley and Cement Creek near by had been filled to near the same height with yellow and white clays, and slate, and conglomerates at a lower level. That the waters reached this level in the deposition of the formations now viewed in fragments is obvious; but the great difference in the rocks of the same valley is not so apparent. Equally perplexing are the water-marks, so fresh on the face of ledges as if the flood had but just subsided.

Such evidence exists in the approach to the Cochetopa Pass from the Atlantic side at an elevation and a level but little below that of the pass.

We do not readily comprehend a common level attaining such an altitude at apparently so recent a date, but rather that these valleys were once a succession of lakes with cataracts between. In the course of time the barriers were cut down, and left the streams and cañons as we now find them. All the phenomena connected with this subject are not solved by this hypothesis; probably volcanic agencies modified the conditions. We have seen in the earlier part of this dissertation that at least one volcano has been in active operation since the topographical features of the mountains assumed somewhat the present form. Others have undoubtedly existed up to this time. These avenues of molten floods may have deluged portions of valleys at different times, or created barriers in great arteries, and thus flooded large sections, or even a whole system of tributary streams. These valleys were then filled up as we have seen, to be cut away as the barriers were worn down.

This is not all conjecture. San Cristobal Falls, on Lake Fork of Gunnison River, are precipitated over a bed of trachyte-porphyry. The remnants of a bed of volcanic trachyte were observed low down in Antelope Park Cañon. Porphyritic trachyte was found in the bed of the valley of Lake Creek, midway between Lake Creek Pass and Twin Lakes, and the extensive deposits of lava on the slope of Saguache Valley. Had the latter occurred at a contracted portion of the valley, it would have been sufficient to produce the indicated results.

*A list of rocks and fossils collected by F. Hawn, geologist of the Ute reconnaissance in Colorado Territory.*

| Names. | Localities. | Date. |
|---|---|---|
| | | 1873. |
| Inoceramus publematicus | Muddy Creek | May 9 |
| Ostria congesta | do | May 9 |
| Graphic granite | Saugre de Cristo Valley | May 13 |
| Gneiss | do | May 13 |
| Granite, (felepathic) | do | May 13 |
| Trachy-dolerite | Sangre de Cristo Mountains | May 13 |
| Trachyte | Camp Loma | May 27 |
| Gray granite | 10 miles above Camp Loma | May 30 |
| Wood opal | Camp 22, in green clay | June 6 |
| White granite | Cement Creek, Las Animas Valley | June 13 |
| Brown granite | do | June 13 |
| Feldstone | Lower slopes Las Animas Valley, in Baker's Park. | June 13 |
| Trachy-dolerite | Cement Creek, high peaks in mountains | June 13 |
| Porphyritic trachyte | Baker's Park, high peaks in mountains | June 13 |
| Trachyte | do | June 13 |
| Volcanic tufa | Cement Creek, high peaks in mountains | June 13 |
| Undetermined | do | June 13 |
| Trachyte | Mineral Creek, high peaks in mountains | June 13 |
| Argillaceous slate | West branch of Mineral Creek | June 17 |
| White sandstone | do | June 17 |
| Quartzose slate | do | June 17 |
| Argillaceous quartzite | do | June 17 |
| Argillite | do | June 17 |
| Feldstone | do | June 17 |
| Brown trachyte | do | June 17 |
| Porphyritic trachyte | do | June 17 |
| Basalt | do | June 17 |
| Calcareous rock | do | June 17 |
| Dolerite | do | June 17 |
| Gray granite | do | June 17 |
| Red limestone | do | June 17 |
| Mica slate | Between Cement and Mineral Creek | June 17 |
| Volcanic tufa | High in the mountains, Las Animas Valley | June 17 |
| Productus costatus | Between Hamilton Park and Animas Park, altitude 8,265. | June 17 |
| P. Cord | As above | June 17 |
| P. Reticulatus | do | June 17 |
| Spirifer lineatus | do | June 17 |
| Spirigera subtilita | do | June 17 |
| Gold quartz | Little Giant gold-lodes, Las Animas Valley | June 18 |
| Compact feldstone | Wall Rock, Little Giant gold-lode | June 18 |
| Crystalline feldstone | Baker's Park, Las Animas Valley | June 18 |
| Bituminous coal | Animas Park | June 20 |
| Productus reticulatus<br>Euomphalus latus<br>Gorgonia | Between Hamilton Park and Animas Park, altitude 8,265. | June 23 |
| Productus reticulatus<br>Spirifer liniatus<br>S. Kentuckensis<br>S. Maconensis<br>Spirigera inflatus | Sec. 1, No. 9 and 19, 3 miles below Hamilton Park, Las Animas Valley. | June 23 |

*A list of rocks and fossils collected by F. Hawn, geologist, &c.*—Continued.

| Names. | Localities. | Date. |
|---|---|---|
| | | 1873. |
| Mica slate | Cunningham's Gulch, Las Animas | June 26 |
| Red quartzite | do | June 26 |
| Quartzite | do | June 26 |
| Red porphyry | do | June 26 |
| Porphyritic trachyte | do | June 26 |
| Quartz porphyry | do | June 26 |
| Trachyte | do | June 26 |
| Trachy-dolerite | do | June 26 |
| Undetermined | do | June 26 |
| Quartzite | 10 miles below Hamilton Park | June 15 |
| Dolerite | South end Animas Park | June 22 |
| Trachyte | Divide between Las Animas and Lake Fork | June 27 |
| Do | Mouth of Godman's Creek, Lake Fork | June 27 |
| Micaceous porphyry | Boundary Mountain, Rio Grande | July 2 |
| Trachyte | do | July 2 |
| Trachyte porphyry | Boundary Mountain, High Peak | July 2 |
| Silver-ore | Lake Fork, near Lower Falls | July 5 |
| Quartzose porphyry | do | July 5 |
| Trachyte | Wall Rock of Lower Falls, Lake Fork | July 5 |
| Trap | Lake Fork Gap | July 7 |
| Agate | Camp 46, Lake Fork Gunnison | July 7 |
| Trachyte porphyry | Between Lake Fork Gap and Lake Fork Cañon. | July 7 |
| Feldstone | do | July 7 |
| Feldspar, trap | Camp 47, head Lake Fork Cañon | July 7 |
| Granite | High grounds west of Lake Fork Cañon | July 8 |
| Rose quartz | do | July 8 |
| Gneiss | Camp 49, between Lake Fork and Ute agency. | July 9 |
| Trachyte | do | July 9 |
| Iron-ore | do | July 9 |
| Nepheline dolerite | do | July 9 |
| Mica | do | July 9 |
| Pitchstone | do | July 9 |
| Trachyte | do | July 9 |
| Volcanic tufa | do | July 9 |
| Trachy-dolerite | do | July 9 |
| Porphyry | do | July 9 |
| Greenstone trap | do | July 9 |
| Hornblende rock | do | July 9 |
| Brown trachyte | Cañon south of Camp 50 | July 10 |
| Do | 1 mile above Ute agency | July 10 |
| Gray granite | Camp 52, Pacific slope, Ute trail | July 12 |
| Trachy-dolerite | On the Atlantic slope | July 13 |
| Trachyte | Saguache Valley, between Camps 53 and 54 | July 14 |
| Red porphyry trachyte | do | July 14 |
| Gray granite | do | July 14 |
| Trachyte | do | July 14 |
| Red trachyte | High Walls, opposite Camp 55 | July 15 |
| Siliceous slate | High Peak, Saguache Valley | July 15 |
| Trachyte | South end Saguache Valley | July 15 |
| Basalt | Where the Rio Grande leaves the mountains | July 19 |
| Amygdaloid | East of Fort Garland | July 29 |
| Trachyte | do | July 29 |
| Granite | do | Aug. 1 |
| Gneiss | do | Aug. 1 |
| Durite | Sangre de Cristo range | Aug. 1 |
| Porphyry | Sierra Blanca spur | Aug. 12 |
| Trachyte | do | Aug. 12 |
| Quartzite | do | Aug. 12 |
| Jaspery quartz | do | Aug. 12 |
| Granular quartz | do | Aug. 12 |
| Trachy-dolerite | do | Aug. 12 |
| Hornblende slate | do | Aug. 12 |
| Greenstone | do | Aug. 12 |

*A list of rocks and fossils collected by F. Hawn, geologist, &c.*—Continued.

| Names. | Localities. | Date. |
|---|---|---|
| | | 1873. |
| Feldstone | Sierra Blanca spur | Aug. 12 |
| Undetermined | do | Aug. 12 |
| Granite | Musca Pass, (Roubideau's Pass) | Aug. 16 |
| Quartzite | do | Aug. 16 |
| Jasper | do | Aug. 16 |
| Argillaceous slate | do | Aug. 16 |
| Flint | do | Aug. 16 |
| Feldstone | do | Aug. 16 |
| Quartzose porphyry | do | Aug. 16 |
| Feldspar | do | Aug. 16 |
| Granular quartz | do | Aug. 17 |
| Metamorphic limestone | do | Aug. 17 |
| Trachyte porphyry | do | Aug. 17 |
| Trachyte | do | Aug. 17 |
| Trachyte | Mouth of Saguache Valley, west side | Aug. 27 |
| Gneiss | Saguache Valley, cut-off road | Aug. 28 |
| Red trachyte | do | Aug. 28 |
| Trachyte | Eastern approach to Cochetopa Pass | Aug. 29 |
| Porphyry | do | Aug. 29 |
| Granite | Lumitchi Valley, Pacific slope | Aug. 31 |
| Porphyry | do | Aug. 31 |
| Quartzite | do | Aug. 31 |
| Hornblende rock | do | Aug. 31 |
| Trachy-dolerite | do | Aug. 31 |
| Hornblende slate | do | Sept. 1 |
| Gray granite | do | Sept. 1 |
| Porphyry | do | Sept. 1 |
| Hornblende trap | do | Sept. 1 |
| Quartzite | do | Sept. 1 |
| Trachy-dolerite | do | Sept. 1 |
| Quartz slate | Cochetopa Valley | Sept. 2 |
| Metamorphic slate | do | Sept. 3 |
| Ostrea congesta | Mouth of Ohio Creek | Sept. 4 |
| Inoceramus, (fragments) | do | Sept. 4 |
| Porphyritic trachyte | Mount Umbraculum | Sept. 5 |
| Syenite | Camp 15, Anthracite Creek | Sept. 6 |
| Volcanic tufa | Camp 15, top of mountain | Sept. 6 |
| Anthracite coal | do | Sept. 6 |
| Porphyritic trachyte | Camp Anthracite Creek | Sept. 6 |
| Feldstone | do | Sept. 6 |
| Syenite | Nigger Gulch Branch, Slate River | Sept. 9 |
| Gray granite | Lone Mountain, on Slate River | Sept. 10 |
| Red granite | Mouth of East River, branch of Slate River | Sept. 11 |
| Gneiss | do | Sept. 11 |
| Quartzite | do | Sept. 11 |
| Calcareous tufa | do | Sept. 11 |
| Red granite | East River Cañon | Sept. 12 |
| Mica | do | Sept. 12 |
| Gneiss | do | Sept. 12 |
| Quartzite | do | Sept. 12 |
| Marble | East River Valley, below cañon | Sept. 12 |
| Trachyte | Dead Man's Gulch | Sept. 13 |
| Porphyritic trachyte | Three miles west of Camp 20 | Sept. 13 |
| Limestone | Between Camps 20 and 21 | Sept. 13 |
| Fusylina | do | Sept. 13 |
| Spirigena maconenis | do | Sept. 13 |
| Spirifer lineatus | do | Sept. 13 |
| Granite | Valley of Taylor River | Sept. 14 |
| Hornblendic granite | West walls to Lake Creek Pass, Pacific slope | Sept. 16 |
| Red granite | Summit of Lake Creek Pass, Pacific slope | Sept. 16 |
| Mica slate | do | Sept. 16 |
| Dolerite | High peak flanking Pacific slope | Sept. 17 |

*A list of rocks and fossils collected by F. Hawn, geologist, &c.*—Continued.

| Names. | Localities. | Date. |
|---|---|---|
| | | 1873. |
| Hornblendic granite | Eastern approach flanking Atlantic slope | Sept. 18 |
| Gneiss | do | Sept. 18 |
| Granite | do | Sept. 18 |
| Trachyte porphyry | do | Sept. 18 |
| Granite, (quartzose) | do | Sept. 18 |
| Quartz porphyry | do | Sept. 18 |
| Hornblende and schoil | do | Sept. 18 |
| Granite, (micaceous) | Granite City, Arkansas Valley | Sept. 21 |
| Granite | Cottonwood Creek, Arkansas Valley | Sept. 23 |
| Porphyry | Camp 28, Arkansas Valley | Sept. 24 |
| Jaspery rock | do | Sept. 24 |
| Diorite | One mile below South Fork, Arkansas River | Sept. 25 |
| Hornblendic rock | do | Sept. 25 |
| Quartzite slate | do | Sept. 25 |
| Trachyte | do | Sept. 25 |
| Quartz and carbonate of copper. | Two miles below the junction of North and South Fork of Arkansas River. | Sept. 26 |
| Carbonite and oxide of copper. | do | Sept. 26 |
| Quartzite slate | Three miles below the forks of Arkansas River. | Sept. 26 |
| Red granite | Foot Hills, Pleasant Valley | Sept. 27 |
| Red granite | Pleasant Valley Cañon | Sept. 27 |
| Mica slate | do | Sept. 27 |
| Trachy-dolerite | do | Sept. 27 |
| Feldstone | do | Sept. 27 |
| Quartz porphyry | do | Sept. 27 |
| Diorite and epidote | Texas Creek, Arkansas Valley | Sept. 28 |
| Quartzite and epidote | do | Sept. 28 |
| Granite | do | Sept. 28 |
| Quartz porphyry | do | Sept. 28 |
| Felstone and quartz | do | Sept. 28 |
| Gneiss | Camp 33, Dry Cañon | Sept. 29 |
| Syenitic rock | Eleven miles below Cañon City | Sept. 29 |
| Trap | do | Sept. 29 |
| Dolerite | Pine Creek, eight miles southwest Cañon City. | Sept. 29 |
| Iron ore | | Sept. 29 |
| Inoceramus problematicus | Cañon City | Oct. 1 |
| I——? | do | Oct. 1 |
| Fish remains | do | Oct. 1 |

## APPENDIX C.—GENERAL TABLE OF INFORMATION.

### *Main line from Pueblo to Garland.*

| Date. | | Stadia distance from Pueblo. | Stadia distance from last camp. | Number. | Name. | Altitude. | Stadia longitude. | Stadia latitude. | Astronomical latitude. | Mean thermometer. | Range of therm ter. | Soil and timber. | Grass. | Water. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | ° ′ ″ | ° ′ ″ | ° ′ ″ | ° | ° | | | |
| | | | | | Pueblo | ...... | 104 36 47.4 | 38 13 45.77 | 38 13 45.77 | ...... | .. | | | |
| May | 7 | 10.68 | 10.68 | 1 | Saint Charles | 5,130 | 104 40 13.8 | 38 05 01.06 | ........... | ...... | .. | Cotton-wood, choke cherry, and willow. | Indifferent | Good. |
| | 8 | 18.14 | 7.46 | 2 | Muddy Creek | 5,560 | 104 43 52.9 | 37 59 34.02 | 38 00 10.7 | ...... | .. | ........... | ....do | Indifferent. |
| | 9 | 34.20 | 16.06 | 3 | Apache Creek | 6,490 | 104 51 54.5 | 37 48 36.57 | ........... | ...... | .. | Cotton-wood, on streams, box-elder, elm, and cedars. | ....do | Good. |
| | 10 | 46.83 | 12.63 | 4 | Badito | 6,530 | 104 50 22 5 | 37 41 45.63 | 37 41 51.0 | ...... | .. | Sage, piñon, pine, and cotton-wood | ....do | Do. |
| | 10 | 60.83 | 14.00 | .. | Summit Sangre de Cristo Pass. | 9,500 | ........... | ........... | ........... | ...... | .. | | ........... | |
| | 11 | 62.79 | 15.96 | 5 | Stem's Ranch | 8,941 | 105 09 59.6 | 37 35 33.69 | ........... | ...... | .. | Piñon, pine, spruce, and aspen | Good | Do. |
| | 12 | 70.36 | 7.57 | 6 | Wagon Creek | ...... | 105 16 20.4 | 37 29 41.45 | ........... | ...... | .. | Soil poor. Spruce, pine, cedar, juniper, and aspen. | Indifferent | Do. |
| | 13 | 81.14 | 10.78 | 7 | Fort Garland | 7,681 | 105 23 28.8 | ........... | 37 23 17.33 | ...... | .. | Soil better. Cotton-wood, spruce, pine, cedar, juniper, and aspen. | ....do | Do. |

### *Main line, Rio Grande and Animas Rivers.*

(Stadia distance from Fort Garland.)

| Date. | | Stadia distance from Pueblo. | Stadia distance from last camp. | Number. | Name. | Altitude. | Stadia longitude. | Stadia latitude. | Astronomical latitude. | Mean thermometer. | Range of therm ter. | Soil and timber. | Grass. | Water. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 7 | Fort Garland | 7,691 | 105 23 28.8 | ........... | 37 23 17.33 | 46.0 | 48 | ........... | ........... | |
| May | 20 | 17.25 | 17.25 | 8 | Sterrit's Ranch | ...... | 105 41 33.5 | 37 25 31.70 | 37 25 43.05 | 43.0 | 16 | Soil sandy and sterile. No timber | Indifferent | Good. |
| | 21 | 24.75 | 7.50 | 9 | Jackson's Ranch | ...... | 105 50 07.1 | 37 28 17.23 | 37 27 18.99 | 57.0 | 22 | Soil fair. Cotton-wood, box-elder, and willow. | Good, but close cropped by cattle. | Do. |
| | 22 | 31.72 | 6.97 | 10 | ........... | ...... | 105 54 12.4 | 37 31 34.75 | ........... | 58.0 | 28 | Soil gravelly near river, sandy one mile from river. Timber as above. | ....do | Do. |
| | 23 | 39.10 | 7.38 | 11 | Fishe's Ranch | 7,675 | 106 01 31.1 | 37 33 22.08 | ........... | ...... | .. | Soil as above. Cotton-wood, box-elder, and willow. | ....do | Do. |
| | 24 | 51.09 | 11.99 | 12 | ........... | ...... | 106 12 52.1 | 37 38 14.10 | 37 37 46.30 | 49.5 | 31 | Soil as above. Cotton-wood willow, and alders. | ....do | Do. |
| | 25 | 54.69 | 3.60 | .. | Loma Village | ...... | ........... | ........... | ........... | ...... | .. | ........... | ........... | |

*Main line, Rio Grande and Animas Rivers*—Continued.

| Date | | Stadia distance from Fort Garland. | Stadia distance from last camp. | Number. | Name. | Altitude. | Stadia longitude. | Stadia latitude. | Astronomical latitude. | Mean thermometer. | Range of therm'ter. | Soil and timber. | Grass. | Water. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | ° ′ ″ | ° ′ ″ | ° ′ ″ | ° | ° | | | |
| May | 25 | 55.59 | 4.50 | .. | Bridge near del Norte | ...... | 106 16 44.39 | 37 38 57.87 | 37 38 30.07 | ...... | .. | ...... | ...... | |
| | 25 | 56.09 | 5.00 | .. | Del Norte Town | ...... | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| | 25 | 59.91 | 8.82 | 13 | ...... | 7,864 | 106 20 48.20 | 37 38 46.02 | ...... | 49.5 | 22 | Soil good. Timber as above and piñon. | Sage on upland, rank grass in bottom. | Good. |
| | 26<br>28 | 70.64 | 10.73 | 14 | Military Camp Lorna | 8,060 | 106 31 56.60 | 37 38 4.07 | 37 38 06.16 | 50.5 | 41 | Piñon, pine, cedar, and juniper | Good, but close cropped. | Water supplied to camps by a acequia. |
| | 29 | 71.81 | 1.17 | .. | Junction of South Fork and Rio Grande. | ...... | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| | 29 | 78.02 | 6.21 | 15 | Lumberman's Ferry | 8,223 | 106 37 11.79 | 37 41 10.58 | ...... | 46.25 | 34 | Spruce, cedar, and pine | Indifferent | Good. |
| | 30 | 84.25 | 6.23 | 16 | Rifle Cañon | 8,248 | 106 42 46.70 | 37 44 06.32 | 37 44 07.97 | 47.0 | 42 | ......do | ...do | Do. |
| | 31 | 85.68 | 1.43 | .. | Junction of Hot Spring Creek and Rio Grande. | ...... | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| | 31 | 86.65 | 2.40 | .. | Wagon-Wheel Gap | ...... | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| | 31 | 92.67 | 8.42 | 17 | Willow Creek Camp | 8,577 | 106 49 10.50 | 37 47 24.50 | ...... | 54.5 | 47 | Willows only, fuel of driftwood. | Indifferent | Do. |
| June | 1 | 97.97 | 5.30 | 18 | ...... | 8,977 | 106 54 13.82 | 37 45 51.61 | 37 45 44.94 | 49.0 | 45 | Coniferæ and aspen | Good in bottom | Do. |
| | 2 | ...... | ...... | .. | Bristol Head | 11,820 | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| | 3 | 107.80 | 9.83 | 19 | On Clear Creek, in Antelope Park. | 8,881 | 107 01 00.18 | 37 44 28.65 | ...... | 49.5 | 19 | A few piñon on ranges; willows in bottom. | Good | Do. |
| | 4 | 113.64 | 5.84 | 20 | On Rio Grande | 9,004 | 107 06 00.00 | 37 42 14.89 | 37 41 44.49 | 37.5 | 21 | Spruce, pine, and aspen | Indifferent | Do. |
| | | | | | Mountain summit near Camp 20. | 10,600 | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| | 5 | 123.70 | 10.06 | 21 | Lost Trail, below Box Cañon of Rio Grande. | 9,398 | 107 15 09.81 | 37 44 17.79 | ...... | 47.5 | 29 | Spruce, pine, and aspen | Good | Do. |
| | 6 | 131.91 | 8.21 | 22 | Junction of Pole Creek and Rio Grande. | 10,385 | 107 22 29.83 | 37 44 15.71 | ...... | 51.0 | 18 | Coniferæ and aspen | Indifferent | Do. |
| | 7 | 134.84 | 2.93 | 23 | On mountain side, Valley of Deep Creek. | 11,373 | 107 25 30.68 | 37 44 29.93 | ...... | 41.0 | 22 | ......do | ...... | Do. |
| | 8 | ...... | ...... | .. | Summit of Mount Canby | 13,100 | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| | 9 | 137.14 | 2.30 | .. | Summit of Hamilton Pass | 12,370 | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| | | | | | Timber line | 11,840 | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| | 9 | 138.75 | 3.91 | 24 | Miners' Rest | 10,869 | 107 28 16.93 | 37 47 00.66 | ...... | 40.0 | 21 | Coniferæ and aspen | Good, but scarce in steep slopes. | Do. |
| | 10 | 141.13 | 2.38 | 25 | Near junction of Animas and Cunningham Creeks. | 9,609 | 107 29 52.77 | 37 48 22.21 | 37 47 21.36 | 47.25 | 31 | ......do | Good | Do. |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 24 | | | | Saint Lawrence Lode, Galena Mountain. | 11, 972 | | | | | | | | |
| | | | | | Timber line, Galena Mountain. | 11, 262 | | | | | | | | |
| | | | | | Summit of Galena Mountain. | 12, 978 | | | | | | | | |
| | | | | | Summit of King Solomon Mountain. | 13, 873 | | | | | | | | |
| | 12 | 148. 50 | 7. 37 | 26 | Junction of Cement and Animas Creeks. | 9, 183 | 107 33 51. 09 | 31 47 06. 56 | 37 46 16. 08 | 47. 8 | 30 | Coniferæ and aspen | Indifferent | Mineral taste. |
| | 14 | 151. 38 | 2. 86 | 27 | | 10, 227 | 107 34 39. 80 | 37 44 47. 49 | | 43. 5 | 21 | Spruce and aspen | Fair | Good. |
| | 15 | 156. 84 | 5. 46 | 28 | | 10, 272 | 107 38 18. 03 | 37 41 54. 34 | 37 41 02. 24 | 47. 5 | 33 | do | do | Do. |
| | 16 | 160. 17 | 3. 33 | 29 | | 9, 911 | 107 40 29. 12 | 37 40 02. 97 | | 44. 0 | 24 | Balsam fir and aspen | do | Do. |
| | 16 | | | .. | Summit of Engineer Mountain. | 13, 266 | | | | | .. | | | |
| | 17 | 164. 50 | 4. 33 | 30 | On Cascade Creek | 8, 742 | 107 43 05. 90 | 37 37 50. 56 | 37. 36 14. 03 | 54. 5 | 41 | Spruce and aspen | Very good | Do. |
| | 18 | 169. 39 | 4. 89 | 31 | | 8, 881 | 107 43 54. 31 | 37 33 55. 23 | | 63. 0 | 32 | Soil good. Spruce, maple, and cotton-wood. | do | Do. |
| | 19 | 179. 61 | 10. 22 | 32 | Soda Springs, Animas Park | 6, 853 | 107 42 35. 01 | 37 25 37. 75 | | 72. 5 | 45 | Soil sandy. Pine, cotton-wood, oak, and cherry. | Good near river; generally poor. | Do. |
| | 20 | 192. 06 | 12. 45 | 33 | On Junction Creek | 6, 629 | 107 46 38. 33 | 37 16 01. 56 | 37 14 31. 49 | 67. 5 | 47 | Soil sandy. Cotton-wood, willow, pine, oak, cherry, service berry, currant, and gooseberry. | do | Do. |

*Main line of Lake Fork of Grand River.*

(Stadia distance from Station 80, of June 3.)

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July | 1 | | | 41 | | 9, 320 | 106 55 25. 47 | 37 44 44. 79 | | 51. 5 | 43 | Coniferæ and aspen | Good | Good. |
| | 2 | 6. 06 | 6. 06 | 42 | Lake Mary | 9, 324 | 107 00 21. 09 | 37 46 35. 22 | | 53. 0 | 50 | do | do | Do. |
| | 3 | 10. 81 | 4. 75 | .. | Clear Creek Falls | | | | | | .. | | | |
| | 3 | 15. 36 | 9. 30 | 43 | | 15, 580 | 107 06 56. 77 | 37 52 13. 14 | | 50. 0 | 36 | Spruce and aspen | Good | Do. |
| | 4 | 17. 36 | 2. 00 | .. | Summit of divide | 11, 356 | | | | | .. | | | |
| | 4 | 20. 77 | 5. 41 | 44 | | 10, 416 | 107 10 31. 00 | 37 55 34. 64 | 37 55 51. 42 | 55. 5 | 41 | Spruce and aspen | Good | Do. |
| | 5 | 21. 77 | 1. 00 | .. | San Cristobal Lake | | | | | | .. | | | |
| | 5 | 24. 77 | 4. 00 | 45 | San Cristobal Falls | 8, 551 | 107 12 51. 95 | 37 58 24. 04 | | 50. 0 | 48 | Spruce, fir, pine, aspen, and few cotton-wood. | Good | Do. |
| | 6 | 25. 22 | 0. 45 | .. | Mouth of Godman's Gulch | | | | | | .. | | | |
| | 6 | 35. 13 | 10. 36 | 46 | | 8, 532 | 107 13 29. 41 | 38 07 04. 00 | | 65. 5 | 29 | Pine, spruce, and aspen | Good | Do. |
| | 7 | 47. 00 | 11. 87 | 47 | Head of cañon of Lake Fork. | 7, 598 | 107 09 13. 38 | 38 16 43. 24 | 38 16 29. 30 | 61. 5 | 47 | Yellow pine, spruce, and cedar | do | Do. |
| | 8 | 50. 65 | 3. 65 | .. | Divide between Camps 47 and 48. | 8, 577 | 107 10 25. 99 | 38 20 52. 10 | | 61. 0 | .. | | | |
| | 8 | 50. 93 | 3. 93 | 48 | Humming-Bird Camp | 8, 365 | 107 05 37. 53 | 38 15 52. 62 | | 54. 5 | 21 | Coniferæ | Good | Do, |
| | 9 | 54. 93 | 4. 00 | .. | Soda Springs | | | | | 78. 0 | .. | | | |
| | 9 | 60. 61 | 9. 38 | 49 | | 8, 625 | 106 56 44. 12 | 38 13 00. 14 | | 61. 5 | 35 | Coniferæ and alder | Indifferent | Do. |
| | 10 | 62. 46 | 2. 15 | .. | Summit of divide | | | | | | .. | | | |
| | 10 | 63. 60 | 3. 29 | 50 | | 9, 620 | 106 53 15. 33 | 38 12 16. 68 | | 54. 0 | 34 | Coniferæ and aspen | Good | Do. |
| | 11 | 66. 60 | 5. 00 | .. | Summit of divide | | | | | | .. | | | |

*Main line of Lake Fork of Grand River*—Continued.

| Date. | Stadia distance from Station 80, June 3. | Stadia distance from last camp. | Number. | Name. | Altitude. | Stadia longitude. | Stadia latitude. | Astronomical latitude. | Mean thermometer. | Range of therm'ter. | Soil and timber. | Grass. | Water. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | ° ′ ″ | ° ′ ″ | ° ′ ″ | ° | ° | | | |
| July 11 | 71. 35 | 7. 73 | 51 | | 9, 150 | 106 46 05. 71 | 38 10 50. 96 | | 56. 0 | 38 | Coniferæ and aspen | Good | Good |
| 12 | 73. 05 | 1. 70 | .. | Ute agency on the Los Pinos Creek. | | | | | | .. | | | |
| 12 | 76. 05 | 4. 70 | .. | Summit of divide, between Los Pinos and Tumitchi. | 9, 482 | | | | | .. | | | |
| 12 | 77. 90 | 5. 85 | .. | Tumitchi Creek | | | | | | .. | | | |
| 12 | 83. 44 | 12. 09 | 52 | | 9, 337 | 106 34 04. 39 | 38 08 52. 75 | 38 08 50. 87 | 55. 0 | 36 | Coniferæ and aspen | Good | Good |
| 13 | 86. 54 | 3. 10 | .. | Summit Cochetopa Pass. (trail.) | 9, 903 | | | | | .. | | | |
| 13 | 95. 59 | 12. 15 | 53 | Saguache Creek | 8, 446 | 106 24 03. 74 | 38 04 54. 99 | 38 06 35. 8 | 59. 5 | 43 | Pine, spruce, and aspen | Good | Good |
| 14 | 109. 39 | 13. 80 | 54 | | 8, 105 | 106 10 53. 33 | 38 04 50. 35 | | 67. 5 | 29 | Cotton-wood, piñon, and willows | do | do |
| 15 | 116. 77 | 7. 38 | 55 | Near Saguache | 7, 710 | 106 03 35. 60 | | | 68. 0 | 40 | Cotton-wood, piñon, and alders | do | do |
| 16 | 124. 77 | 8. 00 | .. | Springs | | | | | | .. | | do | do |
| 16 | 132. 92 | 16. 15 | 56 | Caruero Creek | 7, 609 | 106 08 35. 82 | | | 62. 5 | 23 | Soil gravelly, sandy, and arid | Indifferent | do |
| 17 | 135. 92 | 3. 00 | .. | Garcia Creek | | | | | | .. | Alders and willows | do | do |
| 17 | 146. 81 | 13. 89 | .. | Bridge at Del Norte | | 106 15 43. 95 | 37 41 01. 28 | 37 38 30. 07 | | .. | | | |

*Side line from Camp No. 47 down cañon of the Lake Fork.*

(Stadia distance from Camp 47.)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July 8 | 1. 40 | 1. 40 | .. | Crest of hill above cañon | 84. 57 | | | | | .. | Cedar and oats | | |
| 8 | 5. 92 | 5. 92 | .. | | | 107 10 25. 90 | 38 20 52. 10 | | | .. | | | |

*Main line, (second series.)*

(Stadia distance from Camp No. 53, 1st series.)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aug. 29 | | | .. | Camp No. 53, (1st series) | | | | | | .. | | | |
| 29 | 8. 72 | 8. 72 | 7 | | 8, 680 | 106 28 09. 39 | 38 11 31. 02 | | 65. 0 | 38 | Aspen and scattering coniferæ on mountains. | Good | Good. |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 | 11. 82 | 3. 10 | | Summit Cochetopa Pass, (wagon road.) | 9, 834 | 106 30 55. 52 | 38 12 53. 42 | | | | | | |
| | 30 | 18. 37 | 9. 65 | 8 | Pass Creek | 8, 860 | 106 36 35. 84 | 38 14 28. 18 | | 50. 0 | 46 | Soil good. Coniferæ and aspen. | Good | Do. |
| | 31 | 23. 37 | 5. 00 | | Junction of Pass Creek with Tumitchi Creek. | | | | | | | Artemisia, coniferæ, and cotton-wood. | | |
| | 31 | 29. 59 | 11. 22 | 9 | Cotton-wood Creek | 8, 375 | 106 39 22. 79 | 38 21 47. 35 | | 61. 0 | 34 | Soil sterile. Piñon and willow; five cotton-wood trees. | Indifferent | Do. |
| Sept. | 1 | 38. 69 | 9. 10 | 10 | Junction of Cochetopa and Quartz Creek. | 7, 800 | 106 39 00. 19 | 38 29 42. 37 | 38 28 43. 41 | 55. 5 | 29 | Artemisia, coniferæ, cedars, and cotton-wood. | Good and abundant. | Do. |
| | 2 | 41. 69 | 3. 00 | | Junction of Cochetopa and Tumitchi Creek. | | | | | | | | | |
| | 2 | 45. 95 | 4. 26 | 11 | On Cochetopa Creek | 7, 785 | 106 42 57. 02 | 38 30 55. 32 | | 63. 0 | 34 | Bottom good; slopes stony. Alders, coniferæ, aspen, and cotton-wood. | Good | Do. |
| | 3 | 51. 63 | 8. 68 | 12 | Junction of Taylor River and Ohio Creek. | 7, 700 | 106 50 15. 69 | 38 34 10. 10 | 38 33 14. 69 | 56. 0 | 48 | Poor soil. Cotton-wood and alders. | ....do | Do. |
| | 4 | 64. 93 | 13. 30 | 13 | | 8, 400 | 106 55 18. 70 | 38 44 20. 52 | 38 44 23. 06 | 52. 5 | 41 | Soil good, but arid. Cotton-wood and few coniferæ. | ....do | Do. |
| | 5 | 72. 63 | 7. 70 | | Summit of divide | | | | | | | | | |
| | 5 | 73. 63 | 8. 90 | 14 | | 9, 715 | 106 58 58. 62 | 38 51 40. 96 | | 51. 0 | 34 | Soil poor and swampy. Coniferæ and aspen. | Good | Do. |
| | 8 | 73. 63 | | 17 | Camps 17 and 14 are the same. | 9, 715 | 106 58 58. 62 | 38 51 40. 96 | | | | | | |
| | 9 | 79. 42 | 5. 59 | 18 | Junction of Nigger Creek and Slate River. | 8, 850 | 106 52 52. 49 | 38 52 50. 77 | 38 50 37. 10 | 52. 0 | 38 | Good soil. Coniferæ and aspen. | Thrifty on slopes. | Do. |
| | 11 | 86. 22 | 6. 80 | | Junction of East Fork of Slate River. | | | | | | | | | |
| | 11 | 87. 36 | 7. 94 | 19 | Cañon Creek | 8, 600 | 106 46 41. 46 | 38 49 11. 96 | | 53. 0 | 39 | Soil stony. Coniferæ and aspen. | Fair | Do. |
| | 12 | 95. 61 | 8. 25 | 20 | Deadman's Gulch | 10, 415 | 166 42 10. 08 | 38 51 31. 52 | | 45. 0 | 30 | Soil good. Coniferæ and aspen. | Good | Do. |
| | 13 | 107. 47 | 11. 86 | 21 | In Swampy Glade | 10, 010 | 106 33 35. 60 | 38 54 55. 08 | 38 53 14. 94 | 41. 0 | 36 | Soil sour. Thrifty coniferæ | Poor marsh grass | Do. |
| | 14 | 110. 34 | 2. 87 | 22 | Taylor River | 9, 660 | 106 32 07. 29 | 38 57 04. 42 | | 52. 0 | 48 | Soil good. Coniferæ and aspen. | Good | Do. |
| | | | | | Red Mountain Pass | 12, 908 | | | | | | | | |
| | | | | | Wedge Mountain | 13, 350 | | | | | | | | |
| | | | | | Mount Rowtor | 13, 750 | | | | | | | | |
| | 16 | 119. 54 | 9. 20 | 23 | On Lake Creek | 10, 774 | 106 29 02. 62 | 39 04 52. 39 | | 48. 0 | 34 | Soil stony. Coniferæ and aspen. | Good, but scarce. | Do. |
| | 18 | 129. 20 | 9. 66 | 24 | Twin Lakes, (west end) | 9, 350 | 106 20 37. 05 | 39 07 36. 81 | | 49. 5 | 32 | Soil good, but gravelly. Coniferæ, aspen, and cotton-wood. | ....do | Do. |
| | 20 | 134. 89 | 5. 69 | 25 | Twin Lakes, (east end) | 9, 310 | 106 15 27. 37 | 39 07 32. 27 | | 45. 0 | 32 | Soil upland, dry; bottom good. Coniferæ, aspen, and cotton-wood. | Indifferent | Good. |
| | 21 | 138. 89 | 4. 00 | | Granite City | | | | | | | | | |
| | 21 | 146. 64 | 11. 75 | 26 | Arkansas River | 8, 610 | 106 10 20. 72 | 38 50 51. 88 | | 56. 75 | 36 | Soil upland, dry; bottom good. Coniferæ, aspen, and cotton-wood. | Indifferent | Slightly alkaline. |
| | 23 | 156. 91 | 10. 27 | 27 | Cotton-wood Creek | 8, 235 | 106 07 35. 98 | 38 52 23. 05 | | 52. 5 | 43 | Soil good where irrigated. Pines and cotton-wood. | ....do | Do. |
| | 24 | 175. 15 | 18. 24 | 28 | | 7, 620 | 106 02 49. 60 | 38 36 24. 40 | 38 35 11. 27 | 63. 5 | 39 | Soil good where irrigated. Cedar, piñon, and cotton-wood. | ....do | Slightly brackish. |
| | 25 | 184. 14 | 8. 99 | 29 | Arkansas River, junction of south fork. | | 105 57 08. 27 | 38 29 08. 37 | | | | Soil dry and sandy. Piñon and cedar. | ....do | Do. |
| | 26 | 191. 84 | 7. 70 | 30 | In cañon | | 105 50 14. 85 | 38 25 50. 40 | | | | Rocky. Piñons, cedar, oak, cotton-wood, pine, and willow. | No grass | Do. |

*Main line, (second series)*—Continued.

| Date. | Stadia distance from Camp No. 53, (first series.) | Stadia distance from last camp. | Number. | Name. | Altitude. | Stadia longitude. | Stadia latitude. | Astronomical latitude. | Mean thermometer. | Range of therm'ter. | Soil and timber. | Grass. | Water. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1873. |  |  |  |  |  | ° ′ ″ | ° ′ ″ | ° ′ ″ | ° | ° |  |  |  |
| Sept. 27 | 203.42 | 11.58 | 31 | Pleasant Valley | ...... | 105 42 32.31 | 38 17 19.93 | ........ | ...... | .. | Soil good. Piñons, aspen, and cotton-wood. | Indifferent | Good. |
| 28 | 212.14 | 9.32 | 32 | Texas Creek | ...... | 105 34 19.38 | 38 15 50.65 | ........ | ...... | .. | Soil good. Yellow pine and cedar. | ....do | Brackish. |
| 29 | 224.38 | 11.64 | 33 | Webster Cañon | ...... | 105 24 54.19 | 38 23 07.68 | ........ | ...... | .. | Soil dry. Yellow pine, poplar, oak, and cotton-wood. | ....do | Do. |
| 30 | 232.51 | 8.13 | 34 | Truss bridge | ...... | 105 20 50.52 | 38 28 22.32 | ........ | ...... | .. | Soil dry. Yellow pine | ....do | Do. |
| Oct. 1 | 240.29 | 7.78 | 35 | Near Cañon City | ...... | 105 13 44.37 | 38 24 38.70 | 38 23 57.30 | ...... | .. | ......do | ....do | Do. |

*Side line from Camp No.* 14 *(second series) to Camp No.* 16, *(second series.)*

(Stadia distance from Camp 14, second series.)

| Date. | Stadia distance | Stadia distance from last camp. | Number. | Name. | Altitude. | Stadia longitude. | Stadia latitude. | Astronomical latitude. | Mean thermometer. | Range of therm'ter. | Soil and timber. | Grass. | Water. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sept. 5 | ...... | ...... | 14 | ........ | 9,715 | 106 58 58.62 | 38 51 40.96 | ........ | ...... |  | ........ | ........ |  |
| 6 | 4.37 | 4.37 | 15 | Anthracite Creek | 8,750 | 107 02 06.08 | 38 51 36.88 | ........ | ...... |  | Spruce, fir, pine, and aspen | Vegetation exuberant; fine indigenous oats. | Good. |
| 7 | 8.01 | 3.64 | 16 | ........ | 9,030 | 107 55 14.15 | 38 53 15.11 | ........ | ...... | .. | Very fine, large, conifers and aspen. | Timothy, clover, blue joint, and lichens. | Do. |
| ........ | ...... | ...... | .. | Mount Mill | 12,350 | ........ | ........ | ........ | ...... | .. | ........ | ........ |  |

*Side line up Washington Gulch from Camp No.* 18, *(second series.)*

(Stadia distance from Camp 18, second series.)

| Date. | Stadia distance | Stadia distance from last camp. | Number. | Name. | Altitude. | Stadia longitude. | Stadia latitude. | Astronomical latitude. | Mean thermometer. | Range of therm'ter. | Soil and timber. | Grass. | Water. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sept. 10 | 4.00 | 4.00 | .. | Extremity of line | ...... | 106 53 15.86 | 38 53 39.12 | ........ | ...... | .. | Spruce, fir, pine, and aspen | Good | Good. |
| 10 | ...... | ...... | .. | Timber line Lone Mountain | 12,000 | ........ | ........ | ........ | ...... | .. | ........ | ........ |  |
| 10 | ...... | ...... | .. | Summit Lone Mountain | 12,275 | ........ | ........ | ........ | ...... | .. | ........ | ........ |  |

### *Line from Fort Garland over the Musca Pass.*

(Stadia distance from Fort Garland.)

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aug. | 12 | 7.02 | 7.02 | 1 | ........................ | 7,640 | 105 28 48.11 | 37 27 40.54 | ........... | 71.0 | 30 | Soil gravely, sandy, and arid * ... | Indifferent...... | Fair. |
| | 13 | 16.34 | 9.32 | 2 | ........................ | 7,825 | 105 33 27.83 | 37 34 05.70 | ........... | 64.0 | 24 | ....do .................. | ....do ........... | Good. |
| | | | | | Timber line of Sierra Blanca. | 10,410 | | | | | | | | |
| | 14 | 27.04 | 10.70 | 3 | At entrance to pass.......... | 7,960 | 105 28 04.17 | 37 42 05.74 | ........... | 67.5 | 19 | Soil good * .............. | Good, but scarce. | Do. |
| | 15 | 28.23 | 1.19 | 4 | In cañon..................... | 8,593 | 105 26 45.21 | 31 41 59.06 | ........... | 54.5 | 15 | ....do .................. | .................. | Do. |
| | 16 | 30.23 | 2.00 | .. | Summit of divide............ | 9,353 | 105 24 45.45 | 37 43 19.00 | ........... | ...... | .. | ....do .................. | .................. | Do. |
| | 16 | 34.72 | 6.49 | .. | Farthest point reached on east side of divide. | ...... | 105 19 51.87 | 37 42 07.32 | ........... | ...... | .. | ....do .................. | Good ........... | Do. |

* Timber: Spruce, fir, aspen, pine, and piñon; on the mountain slope, artemisia; in the valley, yellow pine.

### *Line from Camp No. 28 (second series) over the Puncho Pass.*

(Stadia distance from Camp No. 28, second series.)

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sept. | 25 | 7.30 | 7.30 | .. | South Fork of the Arkansas. | ...... | ............ | ............ | ........... | ...... | .. | ........................ | .................. | |
| | 25, 26 | 14.26 | 14.26 | 1 | ........................ | 9,178 | 106 04 21.77 | 38 25 40.48 | ........... | 56.5 | 35 | ........................ | Good, but scarce. | Good. |
| | 26 | 15.00 | 0.74 | .. | Summit of divide ........... | 9,353 | ............ | ............ | ........... | ...... | .. | ........................ | .................. | |
| | 27 | 29.36 | 15.10 | .. | Kerber Creek.... ........... | ...... | ............ | ............ | ........... | ...... | .. | ........................ | .................. | |
| | 27 | 30.86 | 16.60 | 2 | On San Luis Creek.......... | 8,080 | 106 03 13.27 | 38 14 45.70 | ........... | 51.5 | 49 | ........................ | Good ........... | |

### *Reconnaissance of Mr. H. G. Prout up the Taylor River and down the Roaring Fork.*

(Distance from Camp No. 22, main line.)

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sept. | 13 | 15.00 | 15.00 | .. | Head of tributary of West Fork of Taylor River. | 10,860 | ............ | ........... | ...... | .. | | ........................ | .................. | |
| | 15 | 16.00 | 16.00 | .. | Summit of divide.......... | 11,671 | ............ | ........... | ...... | .. | | ........................ | .................. | |
| | 15 | 24.00 | 24.00 | 1 | On Roaring Fork .......... | 10,393 | ............ | ........... | ...... | .. | | Spruce .................. | Good ........... | Good. |
| | 16 | 26.00 | 2.00 | .. | Big Fork .................... | 9,695 | ............ | ........... | ...... | .. | | ........................ | .................. | |
| | 16 | 33.00 | 9.00 | .. | Noon camp ................. | 8,970 | ............ | ........... | ...... | .. | | Spruce, aspen, oak, maple, cotton-wood, choke-cherry, and service-berry. | .................. | |
| | 16 | 43.00 | 19.00 | 2 | Camp on Roaring Fork ..... | 8,230 | ............ | ........... | ...... | .. | | | Good ........... | Good. |
| | 17 | 54.00 | 11.00 | 3 | ........................ | 8,010 | ............ | ........... | ...... | .. | | | .................. | |
| | 18 | 62.00 | 8.00 | .. | Noon camp ................. | 7,224 | ............ | ........... | ...... | .. | | ........................ | .................. | |
| | 18 | 65.00 | 11.00 | .. | Farthest point north........ | 9,249 | ............ | ........... | ...... | .. | | ........................ | .................. | |

*Reconnaissance of Mr. H. G. Prout up the Animas and down the Lake Fork of Grand River.*

| Date. | Stadia distance from Camp 25. | Stadia distance from last camp. | Number. | Name. | Altitude. | Stadia longitude. | Stadia latitude. | Astronomical latitude. | Mean thermometer. | Range of therm'ter. | Soil and timber. | Grass. | Water. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | ° ′ ″ | ° ′ ″ | ° ′ ″ | ° | ° | | | |
| June 25 | 3.45 | 3.45 | .. | Eureka Gulch | ...... | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| 25 | 7.20 | 7.20 | .. | Picayune Gulch | ...... | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| 25 | 9.00 | 9.00 | .. | Forks of the Animas | 10,581 | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| 25 | ...... | ...... | .. | Timber-line | 11,130 | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| 25 | 10.45 | 10.45 | .. | Summit of divide | 12,150 | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| 25 | ...... | ...... | .. | Timber-line | 11,730 | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| 25 | 16.00 | 16.00 | 1 | ...... | 10,300 | ...... | ...... | 37 54 42.37 | ...... | .. | Spruce | Good | Good. |
| 25 | ...... | ...... | .. | Crest of cañon | 9,712 | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| 25 | ...... | ...... | .. | Bottom of cañon | 9,375 | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| 26 | 20.00 | 4.00 | .. | Snare Creek | ...... | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| 26 | 22.00 | 6.00 | .. | Delusion Park | ...... | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| 26 | 23.00 | 7.00 | .. | Noon Camp | 9,141 | ...... | ...... | ...... | ...... | .. | Spruce and cotton-wood | ...... | |
| 26 | 32.50 | 16.50 | 2 | ...... | 8,730 | ...... | ...... | ...... | ...... | .. | Yellow pine, alders, and willows | Fair | Do. |
| 27 | 33.90 | 1.40 | .. | Upper Falls | ...... | ...... | ...... | ...... | ...... | .. | ...... | ...... | |
| 27 | 39.50 | 7.00 | 3 | ...... | ...... | ...... | ...... | 37 56 11.22 | ...... | .. | Spruce and aspen | Good | Do. |
| 28 | 55.10 | 15.60 | .. | Return to Camp No. 39 of main party. | ...... | ...... | ...... | ...... | ...... | .. | ...... | ...... | |

*Side line down Crooked Creek.*

| Date. | Stadia distance from Camp 25. | Stadia distance from last camp. | Number. | Name. | Altitude. | Stadia longitude. | Stadia latitude. | Astronomical latitude. | Mean thermometer. | Range of therm'ter. | Soil and timber. | Grass. | Water. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| June 28 | 10.5 | 10.5 | 39 | Camp near Franklin's Ranch. | ...... | ...... | ...... | ...... | ...... | .. | Soil good; coniferæ and aspen. | Good | Good. |

*Side line up the south fork of the Rio Grande.*

(Stadia distance from Camp Loma.)

| Date. | Stadia distance from Camp 25. | Stadia distance from last camp. | Number. | Name. | Altitude. | Stadia longitude. | Stadia latitude. | Astronomical latitude. | Mean thermometer. | Range of therm'ter. | Soil and timber. | Grass. | Water. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| June 29 | 4.10 | 4.10 | .. | White-Tail Deer Creek | ...... | ...... | ...... | ...... | ...... | .. | Spruce, cedar, and pine | Good | Good. |
| | 6.50 | 6.50 | .. | Extremity of line | ...... | 107 36 20.38 | 37 34 38.31 | ...... | ...... | .. | ...... | ...... | |

### *Side lines in Baker's Park.*

(Stadia distance from Station 96, main line.)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| June 23 | 4.37 | 4.37 | .. | Line up Eureka Gulch ...... | ...... | 107 31 46.77 | 37 49 15.71 | .......... | ...... | .. | Coniferæ and aspen........... | None........... | Good. |

(Stadia distance from Station 88.)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| June 24 | 2.00 | 2.00 | .. | Line up Maggie Gulch ...... | ...... | 107 26 04.12 | 37 46 54.97 | .......... | ...... | .. | Coniferæ and aspen........... | None........... | Good. |

### *Line up Cunningham Gulch.*

(Stadia distance from Station 71, main line.)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| June 26 | 1.40 | 1.40 | 37 | Cunningham Valley........ | 10,113 | 107 28 59.06 | 37 45 07.56 | .......... | 49.5 | 30 | Soil poor. Coniferæ and aspen.. | Fair .......... | Good. |
| 26 | ...... | ...... | .. | Timber line .............. | 11,504 | .......... | .......... | .......... | ...... | .. | .......... | .......... | |
| 27 | 2.80 | 2.80 | .. | Summit Cunningham Pass.. | 11,801 | 107 27 39.04 | 37 43 36.05 | .......... | 57.0 | .. | .......... | .......... | |
| 27 | 5.40 | 5.40 | .. | Rio Grande, below Camp No. 23. | ...... | .......... | .......... | .......... | ...... | .. | .......... | .......... | |

### *Line up the Little Giant Gulch.*

(Stadia distance from Camp 26.)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| June 20 | ...... | ...... | .. | Little Giant Company's mill. | 9,863 | .......... | .......... | .......... | 52.2 | 31 | Bare-slide rock. Aspen and coniferæ. | None.......... | Good. |
| 24 | 4.75 | 4.75 | .. | Extremity of line ........... | ...... | 107 30 29.92 | 37 45 58.40 | .......... | ...... | .. | .......... | .......... | |

### *Line up Mineral Creek, North Fork.*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| June 14 | ...... | ...... | 1 | Campbell's Camp, No. 1..... | 9,385 | 107 34 17.72 | 37 48 08.25 | .......... | 46.75 | 41 | Soil good. Coniferæ and aspen. | Fair .......... | Mineral taste. |
| 16 | 5.20 | 5.20 | .. | Extremity of line ........... | ...... | 107 33 36.60 | 37 51 43.26 | .......... | ...... | .. | .......... | .......... | |

*Line up Cement Creek.*

| Date. | tadia distance. | Stadia distance. | Number. | Name. | Altitude. | Stadia longitude. | Stadia latitude. | Astronomical latitude. | Mean thermometer. | Range of therm'ter. | Soil and timber. | Grass. | Water. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | ° ′ ″ | ° ′ ″ | ° ′ ″ | ° | ° | | | |
| June 18 | 7.50 | 7.50 | 2 | Campbell's Camp, No. 2 | 10,153 | 107 34 17.72 | 37 48 08.25 | ...... | 46.7 | 39 | Soil good. Coniferæ and aspen | Fair | Mineral taste. |
| 19 | ...... | ...... | .. | Extremity of line | ...... | 107 33 36.60 | 37 51 43.26 | ...... | 46.7 | 39 | ...... | ...... | |

(Stadia distance from Campbell's Camp 1.)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| June 17 | 5.70 | 5.70 | .. | Extremity of line up Mineral Creek, (south fork.) | ...... | 107 40 30.88 | 37 43 09.11 | ...... | ...... | .. | Coniferæ and aspen | None | Mineral taste. |

## APPENDIX E.—SUBTABLES OF MINOR DETAILS.

### *Hamilton Pass.*

| Number of profile series. | Feet distant from last station. | Miles distant from Station 0. | Barometer reduced to 32°. | Altitude. | Remarks. |
|---|---|---|---|---|---|
| 0 | | | 20.406 | 10,385 | Camp No. 22. |
| 1 | 8,002.1 | 1.52 | 20.159 | 10,720 | |
| 2 | 2,300.0 | 1.76 | 20.124 | 10.736 | |
| 3 | 1,948.3 | 2.32 | 20.024 | 10,887 | |
| 4 | 1,832 0 | 2.67 | 19.964 | 10,966 | |
| 5 | 1,628.6 | 2.97 | 19.654 | 11,373 | Camp No. 23. |
| 6 | 5,039.6 | 3.93 | 19.309 | 11,826 | |
| 7 | 7,209.0 | 5.29 | 18.924 | 12,370 | |
| 8 | 8,700.6 | 6.94 | 20.019 | 10,894 | Camp No. 24. |
| 9 | 1,666.8 | 7.26 | 20.364 | 10,441 | |
| 10 | 11,109.9 | 9.35 | 21.017 | 9,609 | Camp No. 25. |

### *Musca Pass.*

| Number of profile series. | Feet distant from last station. | Miles distant from Station 0. | Barometer reduced to 32°. | Altitude. | Remarks. |
|---|---|---|---|---|---|
| 0 | | | 22.388 | 7,960 | Camp No. 3. |
| 1 | 900.6 | 0.17 | 22.340 | 8,017 | |
| 2 | 1,176.6 | 0.39 | 22.280 | 8,087 | |
| 3 | 1,469.5 | 0.67 | 22.155 | 8,235 | |
| 4 | 1,263.7 | 0.91 | 22.030 | 8,383 | |
| 5 | 1.611.1 | 1.21 | 21.843 | 8,607 | Camp No. 4. |
| 6 | 1,584.4 | 1.51 | 21.710 | 8,767 | |
| 7 | 1,744.4 | 1.84 | 21.535 | 8,979 | |
| 8 | 1,744.4 | 2.27 | 21.460 | 9,044 | |
| 9 | 1,247.9 | 2.60 | 21.430 | 9,108 | |
| 10 | 1,247.9 | 2.83 | 21.390 | 9,156 | |
| 11 | 3,266.2 | 3.46 | 21.230 | 9,353 | |
| 12 | 2,028.2 | 3.84 | 21.360 | 9,193 | |
| 13 | 3,736.6 | 4.55 | 21.650 | 8,840 | |
| 14 | 4,446.6 | 5.39 | 21.670 | 8,815 | |
| 15 | 7,235.2 | 6.76 | 21.840 | 8,610 | |
| 16 | 3,300.0 | 7.39 | 21.850 | 8,598 | |
| 17 | 2,400.0 | 7.84 | 21.900 | 8,539 | |

### *Lake Fork from Camp No. 47 to crest of Great Cañon.*

| Number of profile series. | Feet distant from last station. | Miles distant from Station 0. | Barometer reduced to 32°. | Altitude. | Remarks. |
|---|---|---|---|---|---|
| 0 | | | 22.686 | 7,598 | Camp No. 47. |
| 1 | 5,413.6 | 1.02 | 22.238 | 8,123 | |
| 2 | 2,278.6 | 1.45 | 24.228 | 8,135 | |
| 3 | 1,796 8 | 1.79 | 21.958 | 8,457 | |
| 4 | 3,130.2 | 2.39 | 22.008 | 8,397 | |
| 5 | 5,182.2 | 3.37 | 22.058 | 8,337 | |
| 6 | 2,800.0 | 3.90 | 22.158 | 8,218 | |

### *Cochetopa Pass, (wagon-road.)*

| Number of profile series. | Feet distant from last station. | Miles distant from Station 0. | Barometer reduced to 32°. | Altitude. | Remarks. |
|---|---|---|---|---|---|
| 0 | | | 22.224 | 8,446 | Camp No. 53, (first series.) |
| 1 | 19,213.6 | 3.64 | 22.250 | 8,415 | |
| 2 | 2,100.0 | 4.03 | 22.210 | 8,462 | |
| 3 | 2,300.0 | 4.47 | 22.180 | 8,497 | |
| 4 | 1,540.0 | 4.76 | 22.160 | 8,521 | |
| 5 | 3,126.2 | 5.35 | 22.080 | 8,616 | |
| 6 | 1,719.0 | 5.68 | 22.040 | 8,663 | |
| 7 | 5,240.0 | 6.67 | 21.930 | 8,795 | |
| 8 | 800.0 | 6.88 | 21.900 | 8,831 | |
| 9 | 4,907.2 | 7.75 | 21.840 | 8,903 | |
| 10 | 1,475.0 | 8.07 | 21.800 | 8,951 | |
| 11 | 420.0 | 8.34 | 21.760 | 8,999 | |
| 12 | 960.0 | 8.52 | 21.720 | 9,047 | |
| 13 | 665.0 | 8.65 | 21.680 | 9,095 | |
| 14 | 1,050.0 | 8.85 | 21.648 | 9,132 | Camp 7. |
| 15 | 8,836.3 | 10.54 | 21.580 | 9,217 | |
| 16 | 695.0 | 10.65 | 21.420 | 9,412 | |
| 17 | 1,155.0 | 10.87 | 21.350 | 9,498 | |
| 18 | 1,381.5 | 11.13 | 21.270 | 9,596 | |
| 19 | 1,179.6 | 11.35 | 21.160 | 9,732 | |

### *Cochetopa Pass, &c.*—Continued.

| Number of profile series. | Feet distant from last station. | Miles distant from Station 0. | Barometer reduced to 32°. | Altitude. | Remarks. |
|---|---|---|---|---|---|
| 20 | 536.4 | 11.46 | 21.120 | 9,782 | |
| 21 | 321.9 | 11.52 | 21.060 | 9,856 | |
| 22 | 295.4 | 11.58 | 21.020 | 9,906 | |
| 23 | 367.1 | 11.64 | 21.010 | 9,918 | |
| 24 | 878.5 | 11.79 | 20.940 | 10,006 | |
| 25 | 426.3 | 11.89 | 20.880 | 10,081 | |
| 26 | 518.1 | 11.99 | 20.930 | 10,019 | |
| 27 | 1,340.6 | 12.24 | 21.080 | 9,831 | |
| 28 | 3,706.6 | 12.94 | 21.300 | 9,559 | |
| 29 | 1,930.2 | 13.31 | 21.360 | 9,485 | |
| 30 | 774.2 | 13.46 | 21.380 | 9,461 | |
| 31 | 679.5 | 13.58 | 21.400 | 9,436 | |
| 32 | 1,810.0 | 13.93 | 21.420 | 9,412 | |
| 33 | 2,000.0 | 14.31 | 21.450 | 9,375 | |
| 34 | 1,750.0 | 14.64 | 21.460 | 9,363 | |
| 35 | 1,160.0 | 14.86 | 21.480 | 9,338 | |
| 36 | 3,740.0 | 15.58 | 21.520 | 9,290 | |
| 37 | 1,230.0 | 15.80 | 21.560 | 9,241 | |
| 38 | 11,100.0 | 17.90 | 21.600 | 9,192 | |
| 39 | 4,940.0 | 18.80 | 21.740 | 9,023 | |

NOTE.—These altitudes are deduced from readings of aneroid referred to Camp No. 53, and differ considerably from heights found if referred to mean at Fort Garland.

### *Cochetopa Pass, (trail.)*

| | | | | | |
|---|---|---|---|---|---|
| 0 | | | 21.235 | 9,337 | Camp No. 52. |
| 1 | 4,492.1 | 0.85 | 21.080 | 9,527 | |
| 2 | 12,500.5 | 3.20 | 20.780 | 9,903 | |
| 3 | 15,531.0 | 6.16 | 21.110 | 9,489 | |
| 4 | 31,829.2 | 12.17 | 21.967 | 8,446 | Camp No. 53. |

### *Red Mountain Pass.*

| | | | | | |
|---|---|---|---|---|---|
| 0 | | | | 9,660 | Camp No. 22. |
| 1 | 1,360.0 | 0.258 | 21.030 | 9,632 | |
| 2 | 1,555.0 | 0.363 | 21.060 | 9,614 | |
| 3 | 1,079.4 | 0.567 | 20.980 | 9,724 | |
| 4 | 1,879.0 | 0.923 | 20.940 | 9,764 | |
| 5 | 1,003.4 | 1.113 | 20.880 | 9,839 | |
| 6 | 892.2 | 1.282 | 20.810 | 9,927 | |
| 7 | 1,318.1 | 1.532 | 20.640 | 10,143 | |
| 8 | 6,725.8 | 2.805 | 20.300 | 10,578 | |
| 9 | 3,825.2 | 3.530 | 20.460 | 10,372 | |
| 10 | 1,893.0 | 3.888 | 20.240 | 10,656 | |
| 11 | 1,932.8 | 4.255 | 20.060 | 10,890 | |
| 12 | 2,720.9 | 4.770 | 19.740 | 11,312 | |
| 13 | 611.2 | 4.886 | 19.550 | 11,565 | |
| | | | 19.440 | 11,713 | Timber line, western slope. |
| 14 | 3,650.4 | 5.577 | 19.110 | 12,208 | |
| 15 | 3,948.4 | 6.325 | 19.680 | 11,438 | |
| 16 | 1,194.4 | 6.551 | 19.740 | 11,358 | |
| 17 | 3,104.2 | 7.139 | 19.840 | 11,226 | |
| 18 | 1,809.4 | 7.482 | 19.920 | 11,074 | |
| 19 | 906.7 | 7.653 | 19.960 | 11,021 | |
| 20 | 2,740.8 | 8.173 | 20.060 | 10,890 | |
| 21 | 2,497.1 | 8.645 | 20.100 | 10,838 | |
| 22 | 2,018.8 | 9.028 | 20.140 | 10,786 | |
| 23 | 1,716.1 | 9.353 | 20.149 | 10,774 | Camp No. 23. |
| 24 | 794.2 | 9.504 | 20.150 | 10,773 | |
| 25 | 476.4 | 9.594 | 20.180 | 10,734 | |
| 26 | 1,611.9 | 9.895 | 20.240 | 10,656 | |
| 27 | 1,438.4 | 10.171 | 20.310 | 10,565 | |
| 28 | 2,447.3 | 10.635 | 20.360 | 10,501 | |
| 29 | 2,037.1 | 11.021 | 20.410 | 10,436 | |
| 30 | 2,543.7 | 11.502 | 20.460 | 10,372 | |
| 31 | 3,461.7 | 11.969 | 20.490 | 10,334 | |

### *Red Mountain Pass*—Continued.

| Number of profile series. | Feet distant from last station. | Miles distant from Station 0. | Barometer reduced to 32°. | Altitude. | Remarks. |
|---|---|---|---|---|---|
| 32 | 406.4 | 12.026 | 20.520 | 10,295 | |
| 33 | 708.4 | 12.161 | 20.550 | 10,257 | |
| 34 | 405.5 | 12.238 | 20.590 | 10,206 | |
| 35 | 1,306.3 | 12.485 | 20.630 | 10,155 | |
| 36 | 1,369.1 | 12.744 | 20.640 | 10,142 | |
| 37 | 1,162.8 | 12.964 | 20.670 | 10,100 | |
| 38 | 3,924.6 | 13.708 | 20.710 | 10,054 | |
| 39 | 3,940.4 | 14.454 | 20.720 | 10,041 | |
| 40 | 915.9 | 14.628 | 20.760 | 9,990 | |
| 41 | 3,790.6 | 15.346 | 20.810 | 9,927 | |
| 42 | 759.4 | 15.488 | 20.840 | 9,890 | |
| 43 | 2,615.8 | 15.985 | 20.920 | 9,789 | |
| 44 | 6,450.6 | 17.207 | 20.930 | 9,777 | |
| 45 | 4,945.0 | 18.143 | 21.080 | 9,569 | |
| 46 | 2,948.4 | 18.701 | 21.273 | 9,350 | Camp No. 24. |

### *Puncho Pass.*

| Number of profile series. | Feet distant from last station. | Miles distant from Station 0. | Barometer reduced to 32°. | Altitude. | Remarks. |
|---|---|---|---|---|---|
| 0 | ............ | ........ | 22.520 | 7,620 | Entrance of Pass at bridge over South Fork of Arkansas. |
| 1 | 3,089.0 | 0.58 | 22.440 | 7,950 | |
| 2 | 739.4 | 0.72 | 22.340 | 8,067 | |
| 3 | 858.1 | 0.89 | 22.300 | 8,114 | |
| 4 | 1,098.1 | 1.09 | 22.260 | 8,161 | |
| 5 | 974.7 | 1.28 | 22.240 | 8,184 | |
| 6 | 1,544.5 | 1.57 | 22.220 | 8,208 | |
| 7 | 3,537.1 | 2.24 | 22.040 | 8,421 | |
| 8 | 2,794.4 | 2.77 | 22.010 | 8,457 | |
| 9 | 1,997.9 | 3.13 | 21.930 | 8,553 | |
| 10 | 1,108.8 | 3.36 | 21.910 | 8,576 | |
| 11 | 1,486.2 | 3.64 | 21.860 | 8,636 | |
| 12 | 2,355.8 | 4.09 | 21.810 | 8,696 | |
| 13 | 1,925.9 | 4.45 | 21.740 | 8,781 | |
| 14 | 1,519.2 | 4.73 | 21.680 | 8,853 | |
| 15 | 2,438.3 | 5.01 | 21.620 | 8,926 | |
| 16 | 1,450.5 | 5.29 | 21,560 | 8,999 | |
| 17 | 2,680.5 | 5.79 | 21.440 | 9,145 | |
| 18 | 2,492.2 | 6.27 | 21.360 | 9,243 | Camp 1. |
| 19 | 2,454.4 | 6.73 | 21.280 | 9,342 | |
| 20 | 1,890.2 | 7.09 | 21.273 | 9,353 | |
| 21 | 1,694.7 | 7.40 | 21.300 | 9,317 | |
| 22 | 2,546.6 | 7.89 | 21.340 | 9,268 | |
| 23 | 1,897.9 | 8.25 | 21.360 | 9,243 | |
| 24 | 1,221.3 | 8.48 | 21.455 | 9,133 | |
| 25 | 6,289.3 | 9.67 | 21.580 | 8,974 | |
| 26 | 3,196.5 | 10.28 | 21.660 | 8,877 | |
| 27 | 6,826.5 | 11.57 | 21.730 | 8,793 | |
| 28 | 2,645.0 | 12.07 | 21.800 | 8,708 | |
| 29 | 5,191.7 | 13.06 | 21.880 | 8,612 | |
| 30 | 3,696.2 | 13.76 | 21.950 | 8,529 | |
| 31 | 3,560.0 | 14.43 | 21.970 | 8,505 | |
| 32 | 6,342.9 | 15.63 | 22.060 | 8,398 | |